DOCUMENT RESUME

ED 188 753 PS 011 512

AUTHOR	Smock, Charles D., Ed.
TITLE	Mathemagenic Activities Program: [Reports on Cognitive/Language Development].
INSTITUTION	Georgia Univ., Athens. Dept. of Psychology.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	[77]
GRANT	OEG-0-8-522478-4617(287)
NOTE	358p.: For related documents, see ED 153 905 and PS 011 510-516.
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	Classification: *Cognitive Development: Comparative Analysis: Comprehension: Early Childhood Education: Elementary School Students: Error Patterns: Foreign Countries: *Language Acquisition: *Logical Thinking: Low Income Groups: Models: Organization: Perspective Taking: *Program Effectiveness: Rural Areas: Semantics: *Social Development: Urban Areas
IDENTIFIERS	Australia: Mathemagenic Activities: *Project Follow Through: University of Georgia

ABSTRACT

This set of 13 research reports, bulletins and papers is a product of the Mathemagenic Activities Program (MAP) for early childhood education of the University of Georgia Follow Through Program. Based on Piagetian theory, the MAP provides sequentially structured sets of curriculum materials and processes that are designed to continually challenge children in kindergarten through third grade from low income families to learn about the physical and social environments. Materials collected here focus on topics related to cognitive and language development. Titles included in the set are: (1) The Use of Mathematical Models for Describing Sequential Search Strategies in Elementary School Children: (2) Measures of Language Comprehension: Relations to Performance: (3) Models for Performance in Syllogistic Reasoning: (4) An Analysis of Organizational Structure by Application of Individual Differences Multidimensional Scaling: (5) Development of Concrete Operations in Urban and Rural Communities: A Study of the Effect of the Mathemagenic Activities Program: (6) A Survey of Cognitive Abilities of Children in Different School Programs: (7) Lifeways and Cognitive Performance in Australia and the United States: (8) Development of Social Relations: Role-Taking Skills and Classification Abilities: (9) The Concepts of Appearance, Disappearance, and Reappearance: A Developmental Semantic Analysis: (10) Analysis of Error Choices on the Ravens Progressive Matrices: (11) Growth of Logical Thought in Rural and Urban Environments: (12) Role-Taking and Egocentricisms: and (13) Children's Conception of Reality: Some Implications for Education. Prefatory or introductory material in each report indicates the focus and purposes of the work. (RH)

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MATHEMAGENIC ACTIVITIES PROGRAM: REPORTS ON COGNITIVE/LANGUAGE DEVELOPMENT.
(Title Supplied)

Charles D. Smock, Editor

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ED188753

The Use of Mathematical Models for Describing Sequential Search Strategies in Elementary School Children

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University of Georgia

July 1973

Prepared for the
MATHEMAGENIC ACTIVITIES PROGRAM
of the
University of Georgia Follow Through Program
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PS011512

This report is based on activities supported by the Mathemagenic Activities Program-Follow Through, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U.S. Office of Education. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U.S. Office of Education and no official endorsement by the U.S. Office of Education should be inferred.

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Preface

Too often we forget that new questions very often require new methods for answering those questions. This paper addresses such a current problem directly. Developmental theory, especially Piaget's operational theory of intellectual development, is a major impetus for many innovative models or instructional programs in early childhood education. The impact of such programs cannot be wholly evaluated by traditional psychometric measures nor statistical methods insofar as the program predicts outcomes different and/or beyond what has been traditionally defined as achievement.

For example, scores on an achievement test may have some relation to logical thought -- but that relation is tenuous -- both empirically and theoretically. Or, statistical techniques that permit analysis of only one cause - one effect relation is not appropriate for determining change in organizational characteristics; i.e., the relations between a set of variables before and after specified experiences. The development of multivariate analysis has expanded our capability in the latter aspects, but often does not permit direct examination of change in the individual's cognitive - organizational characteristics. This paper by Lissitz, Lewis and Brady makes a significant contribution to word development of such a statistical methodology.

C. D. Smock
July, 1973

The Use of Mathematical Models for Describing Sequential Search Strategies in Elementary School Children[1]

Robert W. Lissitz, Philip Lewis, and Patrick Brady

(University of Georgia)

The present study is concerned with the analysis of sequential search data collected from children in first, third and sixth grades. The children were required to make a series of choices about where to look for hidden objects while maximizing the probability of finding the hidden object on each trial and minimizing the cost of searching. The task was designed so that these two goals (maximizing probability and minimizing cost) were inversely related with respect to possible locations of the hidden object.

The search task provided the raw data for a discussion of a variety of approaches to analyzing sequential data. Analysis of variance, the optimal model, a variant of the optimal model, a Markovian analysis and finally an original model based on Markov theory were each presented and applied to the search data. Each of these approaches was contrasted as to their value for researchers.

Perhaps more than any other psychologist in the last thirty years, Jean Piaget has demonstrated the value of careful description of dynamic processes in understanding human behavior. Unfortunately, most American psychologists have continued to study these dynamic processes using classical hypothesis testing procedures which seldom permit an adequate representation of the changing and sequential nature of many of the behaviors being studied. The present paper represents an attempt to illustrate the value of certain alternatives to the classical hypothesis testing model in describing complex problem solving behavior in elementary school children.

The behavior of interest in the present study is sequential search behavior where children are required to make a series of choices about where to look for a hidden object until the object is found. Associated with the choice alternatives are costs for looking and probabilities of finding the object, such that a child can maximize his outcome by simultaneously considering both cost and probability. Since children are instructed to find the object at the lowest possible cost, one obvious strategy for detecting differences among children of different ages is to test for differences in mean cost and mean number of trials needed to locate the hidden object. Such a strategy does not, however, tell much about _how_ children of different ages achieved their particular level of success on the task.

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[1] Subjects for the present study were obtained through the cooperation of the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617(287) Department of HEW, U. S. Office of Education.

In the present investigation several mathematical approaches were explored which permitted inferences about the ways in which children of different ages search (over time) for a hidden object. The most ambitious approach involved comparing the children's search behavior with a mathematical model of the optimal sequential search strategy. Also, a purely descriptive Markov chain model, which makes no assumptions about optimal search efficiency, was examined. This purely descriptive model permitted an assessment of the degree to which predictions could be made about where a child would search on any given trial based on knowledge of where he searched on the immediately proceeding or two proceeding trials. These mathematical approaches were compared with the analysis of variance approach for their descriptive and inferential utility.

Method

Subjects

The _Ss_ were 60 children attending first, third, or sixth grade in an elementary school serving a rural, mountainous region of Georgia. Twenty

Ss were sampled from each of the three grades with males and females equally represented in each group. The first graders ranged in age from 6 years and 4 months to 7 years and 8 months with a mean age of 6 years and 11 months. The third graders ranged in age from 7 years and 9 months to 11 years and 2 months with a mean age of 9 years and 3 months. The sixth graders ranged in age from 11 years and 3 months to 14 years and 4 months with a mean age of 12 years and 1 month. Although teachers were encouraged to select children at random, *Ss* were selected, initially, on their being available at the time needed. First, third, and sixth grade children were used in this study because children in the age range from 6 to 12 are thought to be in a period of development of concrete thought operations (Furth, 1969). During this period children are thought to develop and articulate various thought operations which can, for the first time, be carried out simultaneously. It will be recalled that optimization in the sequential search task requires that both probability and cost be considered simultaneously. Thus, children in the age range from 6 to 12 are expected to show an increasing efficiency on the sequential search task.

Procedure

A graduate student in psychology served as experimenter and saw each child individually in a testing room. Materials employed included a table with chairs, one 7/8 inch black marble, a cigar box containing 50 white poker chips, and three black urns ranging in size from large to small and containing 11, 7, and 3- 7/8 inch white marbles, respectively. Pictures of the "Three Bears" cut from a child's reading book were attached to the three urns, with the largest urn labeled "Poppa Bear", the next largest urn "Momma Bear", and the smallest "Baby Bear". Experimenter and child sat facing each other across the table, and the three urns were positioned on the table so that the child could not see their contents. The child was given the cigar box containing the 50 white poker chips. Additional poker chips were taped to the table top in front of each urn, indicating the "cost" of searching in that urn; one poker chip for the Poppa Bear urn, which contained 11 white marbles, two for the Momma Bear urn, which contained seven white marbles, and three for the Baby Bear urn, which contained three white marbles.

Games involved the experimenter replacing with a black marble, one of the white marbles in one of the three urns. A table of random numbers was used to establish a sequence for choosing the replacement urn for each game. Restrictions on randomization were that no urn appeared more than twice in a row, and each urn appeared at least once in seven games.[2] The child was instructed to search in the urns for the black marble, without looking into the urns, returning to the proper urn each white marble selected. For each search the child paid the E the designated number of poker chips. The child continued searching until the black marble was located or his 50 poker chips were gone. There were a total of seven games for each child in addition to several practice runs. The E recorded, for each step in each game, the urn searched.

Prior to beginning the trials, each child was familiarized with the task and was given an opportunity to examine the contents of each urn and the black replacement marble. The E pointed out that the Poppa Bear urn was the largest and contained the most marbles (11) so that locating the black marble there would the hardest. Each search there, however, would cost less than searching the two smaller urns. Similar explanations by the experimenter were made relating the number of white marbles in each of the two smaller urns to the difficulty of locating the black marble there and to the cost of searching there. Each child was told to try to find the black marble and still end up with as much "play money" as possible. Following these explanations, E asked the child if he had any questions and allowed a few practice searches before beginning the games.

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[2] This restriction does alter the initial probabilities of the black marble being in a particular urn, but at the level of sophistication of the present Ss it was expected to be inconsequential.

Results and Discussion

Analysis of Variance

Data in the present study consisted of seven sets of search patterns for each S plus two summary statistics. One of these statistics was the number of searches to end each trial (finding the black marble) and the other was the number of chips spent on each trial. An investigator interested in age differences in children might typically approach these data using analysis of variance, comparing the performance of children at the three grade levels on the two dependent variables: 1) number of searches to end trials and 2) the number of chips spent. Such an analysis would permit some assessment of the relative "efficiency" of children at different grade levels.

Utilizing a two-way repeated measures analysis of variance, no significant effects were obtained for either dependent variable. The average number of chips spent by all three grades for all seven trials was 25.53, and the average number of searches to find the hidden marble was 13.95. Because of the non-significance of these analyses no further breakdown (post-hoc analyses) of these means is statistically defensible.

Although it was expected that sixth graders would perform more efficiently on the search task than first graders, the fact that there were no significant differences among grades in terms of either average trials to success or chips retained is not necessarily incompatible with Piagetian theory. Piagetian theory is not so much concerned with age changes in efficiency of behavior as it is with changes in the styles or strategies utilized. Statistical procedures which permit one to examine these qualitative differences in behavior would seem to be of more value in this regard than the ANOVA model, which typically focuses on behavioral effects or outcomes.

Optimal Search Strategies

An alternative to the analysis of variance approach to the sequential search data entails comparison of Ss' choices with a model of the optimal sequential search sequence. This general research paradigm has been used with college age Ss by Rapoport, Lissitz, and McAllister (1972), and Kanarick, Huntington, and Peterson (1969). Given certain assumptions, the optimal solution can be derived mathematically. Readers interested in the mathematics of this approach are referred to one of three mathematical articles: Chu (1966), Matula (1964) or Black (1965). The following is a summarization of the optimal model approach, illustrating how it can be used to analyze data from the present study.

For any sequential search procedure in which the S must balance the cost of making a search against the probability of finding the hidden object, a formula exists for dictating his optimal search strategy. First, it can be shown that the probability of finding the object on the jth search, ($j = 1, 2, \ldots T$) of location i ($i = 1, 2, 3, \ldots K$), p_{ij}, is given by

$$p_{ij} = p_i \, (1-m_i) m_i^{j-1} \qquad (1)$$

where p_i is the initial (prior) probability of finding the hidden object in the ith location and m_i is the conditional probability of not finding the object in location i for any given search, given that it is in the ith urn. Since in the present study the searching is done with replacement, the value of m_i is a constant for every j. Values for these variables in the present study are as defined before and are included in Table 1. If c_i is the cost associated with searching in the ith location then the p_{ij} ratio to c_i is directly related to a particular optimum strategy. The optimal policy at each stage is "to search in the location for which there is the highest probability per unit search cost of finding the object in the next search" (DeGroot, 1970, p. 427). This approach will yield the optimal policy with respect to minimizing the expected total search cost. This optimal policy will be called Q_n (π^0)

Table 1

Parameters of the Search Game

	Urn		
	Poppa	Momma	Baby
Number of Marbles	11	7	3
Initial Probability of choosing urn (P_i)	.33	.33	.33
Cost of Searching Each Urn (C_i)	1	2	3
Probability of one search not finding marble, given it is in the urn (M_i)	.909	.857	.667

and the cumulative search probabilities corresponding to it are $P_n(\pi^0)$. Both sets of values are presented in Table II.

Table II

The Optimal Search Policies

	To Minimize Expected Cost			To Minimize # of Trials	
Trial	Search Strategy π^0	$Q_n(\pi^0)$	$P_n(\pi^0)$	Search Strategy π^1	$P_n(\pi^1)$
1	B	.037	.111	B	.111
2	P	.067	.141	B	.185
3	P	.095	.169	B	.235
4	P	.120	.194	M	.282
5	B	.145	.268	M	.323
6	M	.168	.316	M	.358
7	P	.191	.338	B	.391
8	P	.212	.359	P	.421
9	M	.232	.400	M	.451
10	P	.251	.419	P	.479
11	M	.269	.454	M	.504
12	P	.286	.471	P	.529
13	B	.302	.520	P	.552
14	P	.318	.536	M	.574
15	M	.333	.566	B	.596
16	P	.347	.580	P	.617
17	M	.360	.606	M	.636
18	P	.372	.618	P	.654
19	P	.384	.630	P	.672
20	M	.395	.652	M	.688

Table II (continued)

	To Minimize Expected Cost			To Minimize # of Trials	
Trial	Search Strategy π^0	Q_n (π^0)	P_n (π^0)	Search Strategy π^1	P_n (π^1)
21	B	.406	.685	P	.703
22	P	.417	.696	B	.718
23	P	.426	.705	P	.732
24	M	.436	.724	M	.746
25	P	.445	.733	P	.759

Other criteria for optimization exist, and the behavior each implies is different. For example, if the S considers all costs to be equal ($C_i = C_j = 1$) or if there are no costs involved, or if the S wants to minimize the expected number of trials to successful completion of the search, then he should employ equation (1) as it stands. This optimal policy shall be called π^1, and its corresponding cumulative search probabilities are in Table II as P_n (π^1).

Unfortunately it is difficult to apply the optimal policy directly to the S's strategies, since Ss rarely (if ever) behave optimally. Rapoport (1969) did try to apply optimal strategies as models for S behavior and did not find that college Ss searched in a manner which corresponded to the optimal policy. As a result, we rejected the idea that our younger Ss would do so and did not perform the required statistical analysis. Rapoport did go on to modify the optimal policy approach somewhat and this approach is summarized below for our data. The modification consists of considering the optimal search strategy as a stepwise procedure in which the Ss' behavior is analyzed in terms of whether they behaved optimally on the kth trial given what their choice was on the k-1 trial. Table III summarizes these results, and as can be seen, even with the conditional optimum approach these Ss do not seem to have adopted the

Table III

The Actual Search Strategy as a Per Cent of the Stepwise Optimal Strategy: For Each Grade Level

	Stepwise Optimal	Actual		
		Pop	Mom	Baby
Grade 1	Pop	.344	.357	.299
	Mom	.578	.297	.125
	Baby	.427	.353	.220
Grade 3	Pop	.409	.367	.244
	Mom	.536	.305	.158
	Baby	.422	.312	.267
Grade 6	Pop	.442	.364	.193
	Mom	.673	.257	.069
	Baby	.378	.305	.317

prescribed solution.

These data suggest that although there are slight increases in the degree to which Ss optimize their outcomes as one moves up the three grade levels, children between the ages of 6 and 12 do not appear to show markedly different strategies on the sequential search task. It seems probably that the present task requires formal operational thought processes not yet attained by the present Ss, or as Rapoport (1969) suggests, not attained by college students either.

Markov Chain

A third approach to these data involves the use of a Markov model in an attempt to provide an equation for describing the search behavior of the present Ss. The Markov approach includes no assumptions about optimization. Rather, a simple assessment is made of the predictability or degree of regularity of

Ss' search behavior.

There are a number of sources (Kemeny and Snell, 1960) that provide good accounts of the mathematical characteristics of the Markov model. In addition, Gribbons, Halperin and Lohnes (1966) describe the use of the model in education, Lu (1966) utilizes the model for describing the transmission of dental carries from site to site on a tooth, Guthrie and Youssef (1970) provide three references which use Markov models for studying weather phenomena. There are just a few examples in addition to the article by Rapoport (1969) which used the Markov model to describe search behavior.

The parameters of the model are a vector $\pi = (\pi_1, \ldots, \pi_k)$ of initial probabilities and matrices $P_t = (p_{ij}(t))$ of transition probabilities, where π_i represents the probability that an individual will be in state i at the initial observation and $p_{ij}(t)$, the conditional probability of occupancy in state j at time t, given state i at time t-1. The subscripts i and j represent the states of the model, of which there are k in total. The observational periods are called stages, denoted by the index $t = 0, 1, \ldots, T$.

The initial vector π, in this study, contains the student's probabilities of choosing each of the three urns at trial one. In other words, they represent the biases that the students bring to the game as contrasted to the probabilities that are modified by events of the game. The transition matrix P_t, contains the probabilities that govern a choice of a particular urn given some other urn or urns have been chosen on earlier trials (stages).

Before these parameters may be applied, the process underlying the observations must satisfy certain conditions. These conditions will be referred to as the assumptions of the model. The first of these assumptions concerns the order of the process. A process is of order one if residence in state j at stage t is dependent on the state occupied at stage t-1, but is in no way influenced by stages prior to t-1. Transition probabilities for an order one process are completely determined by the mXm matrices P_t.

If occupancy in a state at stage t is independent not only of stages prior to t-1, but is also independent of stage t-1, the process is said to be of order zero, or independent. In this case, the rows of the matrix P are equal, allowing transition probabilities to be reported in a vector rather than a full matrix. It is possible to generalize in the direction of greater dependence, resulting in a process of higher order. For example, if the process is of order two, residence in a state at stage t is dependent upon residence not only at stage t-1, but also at t-2. Thus, for an order two process, transition probabilities would be summarized in a three dimensional matrix.

A second condition imposed on the process is stationarity. The process is said to be stationary if transition probabilities are independent of time (i.e., $p_{ij}(t) = p_{ij}$ for all $t = 1, \ldots T$). The transition probabilities P_{ij} are summarized in a single matrix P of dimension mXm when the process is stationary.

In this experiment, the order and stationarity assumptions may be summarized as follows: order has to do with degree of dependency, where dependency is a function of the number of trials. If a student makes his selection of an urn on some particular trial based only on what he did on the previous trial when the dependency is only over one trial and hence called order one dependency. Stationarity is somewhat more complicated, but the idea is that different probabilities of transition from urn to urn are needed at different points in time. For example, the student might have one transition matrix for the early trials and then when he gets discouraged he may change matrices and adopt (implicitly) some different set of probabilities.

Anderson and Goodman (1957) provide formulas for fitting the general stochastic model of any order, whether stationarity is assumed or not. They also provide formulas for testing the assumptions of order and stationarity which are made if the user wishes to adopt a Markov chain model. Anderson and Goodman provide two tests for this purpose and also provide the limiting distribution theory for applying these tests to "large samples". There has been some attention in recent literature (Guthrie and Youssef, 1970, Lissitz, 1972) to the small sample problem of testing and assumptions of order and stationarity, but these will not be discussed here.

Because the results from the earlier reported analysis of variance and our observations of Ss suggest that Ss are not changing systematically over trials we decided to assume, without test, that these data can be modeled (if at all) by a stationary Markov process. It is important to realize that for most cases of modeling with a stochastic model no simple model is likely to be completely "true". In other words, even though a process might be largely order one there is almost certainly going to be some small dependency upon the t-2 stage and even the t-3 stage, etc. In other words if the tests were sensitive enough they would probably reject any Markov model as being the correct one.

A preliminary analysis of the transition matrices of individual Ss suggests that there would be no justification for averaging over Ss to obtain a composite transition matrix. In other words, the Ss are very heterogeneous and no single matrix is going to represent their behavior. There is another reason for not combining matrices and this involves the interests of this study. We would like to look at search behavior models that are indicative (predictive and descriptive) of individual behavior since the search task was pursued on an individual basis, and Piagetian theory puts its focus upon individuals.

The following analysis will consist of the presentation of some selected transition matrices (estimated conditioned probabilities and associated frequencies of reasons) that are illustrative of both the actual child search behavior and the nature of the Markov model as a descriptor of this behavior.

Case I

The following order one stationary transition matrix was found for a first grade student:

	Pop	Mom	Baby
P	.898 (53)	.068 (4)	.034 (2)
M	.070 (4)	.895 (51)	.035 (2)
B	0.0 (0)	.267 (4)	.733 (11)

and the following is his order two stationary transition matrix:

		P	M	B
	P	.902 (46)	.078 (4)	.020 (1)
P	M	0.0 (0)	.750 (3)	.250 (1)
	B	0.0 (0)	0.0 (0)	1.00 (1)
	P	1.00 (4)	0.0 (0)	0.0 (0)
M	M	.064 (3)	.915 (43)	.021 (1)
	B	0.0 (0)	.50 (1)	.50 (1)
	P	0.0 (0)	0.0 (0)	0.0 (0)
B	M	0.0 (0)	1.0 (4)	0.0 (0)
	B	0.0 (0)	.273 (3)	.727 (8)

A comparison of these two transition matrices indicates that this subject is operating with a sequential search policy that is of order one, i.e., a knowledge of the state (urn) that was searched at the t-2 stage is useless for predicting where that S will search on stage t. A typical search sequence for this subject was PPPPPPPPPBBMMMMMMMMMMMMMPPP. Descriptively speaking, this subject tended to perseverate in his searches which is indicated by the large values in the main diagonal of the order one transition matrix.

Case II

This is another first grader who had a rather simple search strategy that can be represented by an order one stationary Markov chain as follows:

	P	M	B
P	.026	.974	0.0
M	.051	.077	.872
B	.970	.030	0.0

As you can see from the transition matrix this S had a search policy (with a few exceptions) as follows: PMBPMBPMB... This is also a repetitive strategy, but of a very different kinds from what we called perseverative.

The two examples above indicate some of the behavior that can be described by Markov chains as well as to suggest a further analysis that will be first presented in a descriptive way and then in a more formal manner. An analysis of individual Ss suggests that some used a very stereotyped search pattern and some quite unstereotyped. We initially isolated three specific stereotyped search strategies, and their frequency of occurrence is presented in Table IV. As can be seen these data suggest that first graders responded to this task with stereotypic response patterns much more often than did the third or sixth

Table IV

The Number of Stereotypic Response Patterns

Type of pattern						
PMBPMB...	3	0	0	0	0	0
PPMMBBPPMMBB...	2	0	0	0	0	0
PPP...MMM...BBB	3	3	2	2	0	1
TOTALS	8	3	2	2	0	1

a) three trials with 8 or more consecutive or 4 trials with 7 or more consecutive stereotypic responses

b) three trials with 6 or 7 consecutive stereotypic responses

graders (who look similar with respect to this dependent variable). This analysis was directly suggested by the inspection of the set of transition matrices for the individual Ss in the three grades. Actually, listing the specific types of stereotypic behavior is a perfectly respectable way to define them but some more general (i.e., basic) definition would be preferred. The last section of this paper is an attempt to apply notions from stochastic modeling to the problem of defining and theorizing about search behavior (or any other sequential behavior).

Markov Theory and Sequential Behavior[3]

The previous section suggests an approach to the description of sequential behavior that involves the use of Markov terminology to classify search strategies of children and therefore, the children themselves. The following breakdown is suggested:

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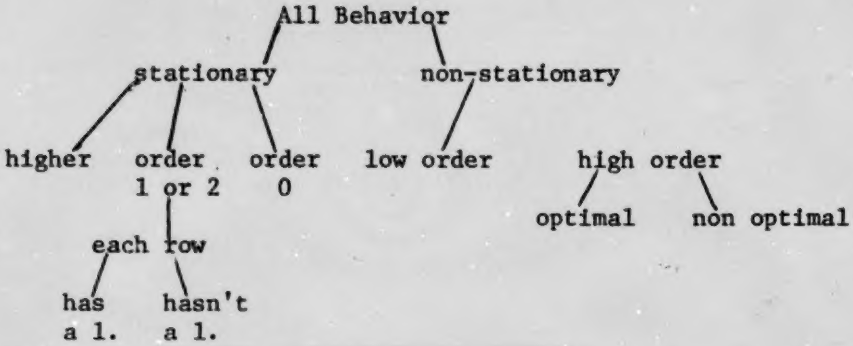
[3] A different but related approach to defining stereotypic behavior through the use of information theory has been described by Frick and Miller (1951), and Miller and Frick (1949).



Each of the end points above has a definite interpretation that can be summarized as follows:

1. Stationary-higher order: These are complex patterns that are governed by a very large transition matrix that applies to every trial after the initial. The inference (theory) is that persons using this strategy are doing so in some intellectual manner.

2. Stationary-order 1 or 2: These are persons who are also making an intellectual attempt at optimization (again without knowing the "mathematically correct" solution). Two types of search strategies have been distinguished and these will be returned to shortly.

3. Stationary-order 0: These Ss adopting these policies are behaving randomly (independently) on each trial. These Ss could be bored with the task, frustrated with the task, or perhaps awed by the task, but at any rate they do not know what to do, so they are trying anything that comes to their mind.

4. Nonstationary and low order: These are Ss that are trying a variety of fairly simple search strategies.

5. Nonstationary and higher order: These are distinguishable into two categories -- those Ss who are using the optimal strategy and those that are using very complex changing strategies.

Before returning to category number two it should be noted that Ss may be using strategies that are apparent from the data analysis and yet these same Ss might not be able to articulate their strategy verbally. The notation "has a 1 and hasn't a 1" means that order one or two matrices may be distinguished according to their probabilities and that a very meaningful distinction is between those matrices having a one and zeros in each row, and other matrices. A probability equal to 1 means that the series is a deterministic one and, in fact, the examples of transition matrices that were included in the previous section of this paper and called "perseverative" were very close to being of this type. Those matrices without 1s are indicative of probabilistic, but still consistent behavior.

The matrices that are stationary and order one and two but are such that every row has a 1 in it summarize behavior that shall be defined as Stereotypic search behavior. It can be seen that this definition of stereotypic behavior is such that the behavior is fairly simply (of low order) deterministic (probability of 1.), and consistent over trials (stationary). This is a term that is well defined but likely to exclude every S if rigorously applied. Instead of relaxing the definition, for example demanding that the probability be greater than or equal to .95 instead of 1. a measure of goodness of fit will be suggested. This measure called S will be defined as

$$S = \underset{a \varepsilon A}{\mathrm{MIN}} \left\{ \sum_{i}^{n} \sum_{j}^{n} (x_{ij} - a_{ij})^2 \right\} \qquad (2)$$

where the a_{ij} are values contained in the model transition matrix A, x_{ij} is from the estimated transition matrix X. By MIN is meant that the value of S is found by choosing the Stereotypic matrix with a 1 in the column of each row that will minimize the average of squared deviations, i.e., the minimizing set of a_{ij} from all possible a_{ij}. The following is an example of the application of this model to case II in the previous section:

By setting A equal to:

$$\begin{matrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{matrix} \quad \text{we have}$$

$$S = (.026-0)^2 + (.974-1.)^2 + \ldots. +(0-0)^2 = .028$$

Table V summarizes the analysis of this set of data by application of equation (2) where the a_{ij} are from an order 1 stationary matrix of ones and zeros. People who are well fit by this model are what we defined as "perseverative" people in the tree diagram breakdown of "all behavior". It is clear that the means differ a great deal between the three age groups, but looking at individual behavior is much more interesting if we arbitrarily use .4 as a cut-off for deciding whether people are in the perseverative category or not, then it can be seen that first graders had 10 of the 20 children defined as perseverative. Of the third graders only one is perseverative and none of the sixth graders are perseverative.

The basic conclusion is similar to that found in table IV but now the perseverative students are one class of an objectively defined system. This same sort of analysis could be repeated with the other categories to isolate those students who are well fit by each of the five model classes of behavior.

Summary and Conclusions

We hope that this paper has accomplished several things. One of these is to present some interesting data (and corresponding experimental paradigm) concerning children's search behavior. A second is to present a theoretical framework with which to view sequential behavior of many types. A third

Table V

Values of S for Each Subject in Each Grade

Subject	1st Grade	3rd Grade	6th Grade
1	.002	.850	1.426
2	.986	.163	.922
3	1.435	.532	1.432
4	.375	.634	1.379
5	.040	1.340	.754
6	.991	.912	1.273
7	1.172	1.415	.466
8	1.037	1.328	1.283
9	.078	1.432	.640
10	.028	1.032	.966
11	.367	1.342	1.463
12	.279	1.274	.811
13	.219	1.014	.873
14	.176	1.303	1.146
15	.022	1.178	1.517
16	1.564	1.263	.847
17	1.000	1.223	1.070
18	.878	1.036	.471
19	1.230	1.501	1.055
20	1.399	1.182	1.145
Mean	.659	1.098	.997
Standard Deviation	.543	.340	.325

motivation was to present a series of analyses that illustrate a variety of data-analytic styles. The following makes this continuum more explicit and ends with a value judgment about model building, in general.

The first approach to the data was that of analysis of variance. This approach is typically not concerned with model building at all. The E is strictly interested in the probability of certain events given some associated statement of those events (the null hypothesis). The second approach is all model and no empirical considerations interfere. This was the case where the E derives or borrows a derivation from someone else and the derivation specifies the sequence of behaviors that a subject should engage in, given some criterion to optimize. This specifies the behavior of some mythical subject who probably doesn't exist anywhere but provides an interesting contrast to real subjects. The next approach that we took to this data modifies the optimal model and calculates a conditional optimal solution that was called stepwise optimal. This is an attempt to become more empirical and descriptive but not to lose sight of the optimal solution altogether.

The next method was to lose the optimality approach altogether and simply adopt a descriptive model that makes a few assumptions about the nature of the process but is largely determined by the behavior itself. The Markov model is one such approach, and can yield a nice post-hoc description (summary) of reality.

The final approach to modeling involves borrowing some notions from Markov processes but to define the model with specific relevance to sequential search behavior in real children. It is our contention that mathematical models based upon some theory and derived for a specific application hold the most promise for psychologists.

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Measures of Language Comprehension: Relations to Performance

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July 1973

Prepared for the

MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH

of the

University of Georgia

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PS 011512

This report is based on activities supported by the Mathemagenic Activities Program-Follow Through, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U.S. Office of Education. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

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Preface

The theories of Piaget and Chomsky continue to be major influences in the study of language acquisition and development. Each of these theorists, in his own way, makes a distinction between competence and performance. Too often the implication of this distinction eludes researchers of cognitive developmental processes. Such has been the case in the study of children's language, especially with respect to the sequential relation of comprehension, production and imitation. Dr. Cocking confronts this issue from the point of view of social learning theory. The discussion based on his research adds clarity and information relevant to both methodological problems and the substantive gaps in our current knowledge of language acquisition.

C. D. Smock
July, 1973

Measures of Language Comprehension: Relations of Performance[1]

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Abstract

Initial attempts in the study of the relations between language comprehension, performance, and imitation concluded with statements that imitation was a precursor to comprehension and production, and that it should be relegated to the sphere of perceptual-motor behaviors. The present study looked at the differential effects upon a learning task of two different types of comprehension measures. Comprehension tasks, which required the child to process the string of elements, related to performance on new language learning tasks, whereas the inquiry measure of comprehension, which explores the child's knowledge of actor, action, and acted-upon in the same string of elements, was not related to learning. The conclusion was that there is evidence for two considerably different kinds of comprehension and only one of them relates to performance. The present study indicates that the sequence of development as couched in social-learning theory and observational-learning principles, is Comprehension-Production-Imitation. Other variables, such as performance by verb-type, are also discussed in relation to the two measures of comprehension.

The apparent redundancy in the title I have chosen, I am sure, hasn't eluded anyone. To speak of the relationships of comprehension to performance is the same as saying, "How does performance relate to performance?" if you follow David McNeill's rather cogent argument that comprehension, as well as language production, is a performance behavior. It is these very interrelationships of performance variables which I should like to pursue. My discussion points are these: (1) comprehension may be assessed in different ways; and (2) not all comprehension measures relate to performance on new language learning tasks, which might lead one to believe that there are different kinds of comprehension.

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[1] This paper was presented at the annual Southeastern regional meetings of the Society for Research in Child Development. Williamsburg, Virginia, April, 1972. The work on which this report is based was supported in part by the Mathemagenic Activities Program - Follow Through under Grant Number OEG-0-8-522478-4617 (287) Department of HEW, U.S. Office of Education, and by grants from the Department of Human Development and Family Relationships, Cornell University, and The College of Human Ecology, Cornell University.

The first problem, and the one really central to this report, is "What constitutes comprehension?" Is it the understanding of a sentence, an understanding of structural parts of the sentence, is it an understanding of lexical items? All of these, of course, are language comprehension indices, but if we wish to look at language learning as a criterion measure, then we have to focus on the structural aspects; that is, upon the different syntactic structures and upon the structural elements which constitute the sentence. And these are the two kinds of comprehension I wish to discuss.

Probably the best-known research team in the study of early child language is the Harvard group headed by Roger Brown. One of the people once associated with that group was Ursula Bellugi (now Bellugi-Klima) who devised a method of assessing language comprehension in preschoolers which did not necessitate any language production on the part of the child. The kind of comprehension assessed by the technique is the understanding of a complete sentence. The procedure involves presenting a different array of manipulatable objects for each of a series of different language structures. The child's task is to perform according to the statement an experimenter makes about those objects. For a preposition item the child may be told to perform the various behaviors of putting a ping pong ball under, behind, next to, and on top of a paper cup. The present research focused upon the child's learning the passive structure, with particular attention to the reversible passive. Therefore, the items presented in the Bellugi format were only of this type. For example, the child was presented with two small dolls, a boy and a girl, and E demonstrated the verb "chase" in the active voice. The child was then asked, "Show me: 'The boy chases the girl', or 'The girl chases the boy'." The toys were placed in the original positions and then the child was asked to perform the same action, that is the semantic content remained unchanged, but the E this time made the statement in the passive voice, "Show me: 'The girl is chased by the boy', or 'The boy is chased by the girl'." Notice that the child was always asked to perform the action in the active voice first so that one could be sure the child understood the basic content of the task. This is not the procedure of the Bellugi test, but one employed here since I was focusing upon only one language structure and because of a research design: I was trying to select a subject sample who understood the content of the task but who could be further subdivided into those who understood reversible passive transformations and those who did not. This first type of assessment of children's comprehension, then, involves the child's understanding of a complete sentence structure and then manipulating the objects in the way he understands that statement.

A second way of assessing comprehension is to probe, through inquiry, the child's understanding of the elements of a statement. Recall that I asked in the passive, for the child to show me "The boy is pushed by the girl." After replacing the objects in their original positions and repeating, "The boy is chased by the girl," I asked the additional questions of, "Who chases?", "Who is chased?" and "Who gets chased?" The "got" form was included as an immature passive form which children use and which, it was thought, might also be understood before the true passive form. As you can see, this second procedure for assessing comprehension looks at the subject-verb-object (SVO) or the actor-action-acted-upon components of the same sentences which the Bellugi procedure requires responding to as a connected sequence.

Each of these kinds of language comprehension is a performance measure. Language production, too, is a performance variable in the study of children's language, and just as comprehension could be variously defined, language production has been assessed in different ways. One of the most interesting ways has been a verbal imitation method. It has shown us how the child, at various age levels, alters the statement in accord with his current level of development. Thus, at early points in the child's language learning his repetition of a question presented by an experimenter will not reflect the verb position change required in the structure. The statement "Who is that?" will be produced as "Who that is?" or "What time is it?" will be produced as "What time it is?" Thus, repetition has been one way of assessing language production performance. The method, however, generally has been referred to as an "imitation" procedure, and programs which have used the format for teaching language to young children have been called "imitation" procedures.

Just as language comprehension could be looked at differently, as I said, so may production. Recall again, if you will, that the child's productions are not always identical to the statement as presented to him --

that he alters the structure in terms of his present knowledge. These imperfect attempts may be demonstrative of the child's attempts at new language structures. Just as I tested to see if children had varying degrees of language comprehension, I also tested children's productions on a picture-story completion game. The format was the same as that used by Dr. Marion Potts at Cornell University. Using pictures to tell a story, the child is required to complete the story in terms the story and pictures prescribe. In the present case, the last picture in the series was to evoke the reversible passive. For example: "I have a cat and a dog (picture of each). They like to play and chase each other. Sometimes the cat chases the dog (picture) and sometimes the dog chases the cat (picture). Here the cat (picture of dog chasing cat) ____________." The response requires the passive: "the cat is chased by the dog."

Now, just as the previous repetition method can be used as a training procedure in teaching language to children, so may this. The technique followed, however, was not one of direct teaching, but one of allowing the child to observe, via video tape, two people engage in this same interchange as a tester and a subject would; that is, one person always presented the pictures and told the stories in the active voice and the other always completed the stories in the passive voice. In the present study it was an adult or a child on the tape who completed the stories in the passive, and adults always served in the "tester" role for various treatments. That aspect of the research is not what I want to focus on right now, however. What I would like to point out is that, in terms of social-learning theory, the productions which approximate correct reversible passives when the observing child is given a chance to play the game as he watched it played on T.V. constitute "observational learning" on the part of the child. And in the terminology of observational learning theory _a la_ Bandura, this technique also may be labeled an "imitation" procedure. Care was taken to establish that this was new language learning by testing in advance and selecting a sample of subjects who did not exhibit language production capacity for the reversible passive. What I wish to discuss, now, is what the various kinds of language comprehension mean in relation to performance on a task of _new_ language learning as described here.

The Bellugi test had been used to divide the subjects into Comprehension and No-Comprehension groups. After co-varying for age differences among these 3½ - 5-year-old children, performance on the observational learning task was shown to be significantly affected by the factor Comprehension ($p < .002$).

The Comprehension and No-Comprehension groups were defined by the Bellugi test, as I have said. However, even the children who were labeled as Non-comprehending _Ss_ for the study exhibited "comprehension" when the inquiry-probe method was used. If one adjusts for both age and these varying degrees of component-comprehension -- that is, knowledge of the actor-action-and acted-upon elements -- through co-variance, he finds that comprehension in terms of a complete sentence - the Bellugi type - becomes an increasingly important factor in language learning, rather than being attenuated. This is to say, it is comprehension of the connected sequence rather than of parsed elements which relates to new language learning through observation ($p < .001$).

The experimental design allowed us to look at the probe-inquiry type of comprehension during the last block of learning trials, and using the difference between the initial and final probe scores for each child, a change in comprehension score, Δ comp., was also obtained. It was asked, when knowledge of the actor-action-acted upon elements changed during exposure to the language learning session, where the change was predictive of task performance. The results again revealed that when differences between subjects in age and capacity for change in inquiry-comprehension are adjusted, it is the Comprehension score reflecting intact sentence processing which relates to performance ($p < .001$).

Let me summarize to this point and then go on and discuss what these findings represent to me. Comprehension was viewed in two different ways: through a Bellugi-type format, whereby the child is told to perform a certain action with some toys, and through a probing of what's happening in terms of the actor-action-acted upon sentence components. This latter procedure was employed prior to and subsequent to exposure to the learning treatment and a change in inquiry probe comprehension became another way of looking at comprehension relations to performance. The results indicated that performance on new language production tasks was a direct function of comprehension as measured by the Bellugi format ($p < .002$); that the Bellugi technique remained significantly related to observational (imitative) language learning even when comprehension differences, as obtained through probe-questions, were adjusted for in the analyses ($p < .001$); and that co-varying for change in inquiry-comprehension scores did not alter these effects: Bellugi comprehension was the overriding factor associated with performance on the production task. It should also be added that this last analysis had the additional effect of adjusting for any language-learning ability differences by C and Non-C groups which might have been present: ability for change was co-varied through Δ comp.

So far, this paper has not really dealt with the issue of "degrees of comprehension." The topic was adumbrated by remarks which indicated that varied degrees of knowledge of the actor-action-acted upon components did not appreciably affect language learning. But what of the various competencies displayed on the Bellugi-type measure? Is comprehension of the sentence sequence an all-or-none proposition, or do varying degrees of knowledge, that is, the range of test scores, reflect and indeed predict, differences on language learning tasks? For the moment we shall focus our attention on this range of scores within the Comprehension group of subjects. The data of the study showed that adjusting for this kind of group variability among subjects who responded above chance-level on the Bellugi-type measure, that is, among subjects classed as displaying Comprehension, had negligible effect upon the dependent variable, performance on new language learning tasks. The global categorization by the Comprehension/No-Comprehension dichotomy characterized the responding: performance, or new learning, was related to Comprehension, but not to "degrees" of Comprehension. It would appear that even though the child makes errors, when his correct reresponding is above a chance-level, he does indeed comprehend sufficiently so as to be capable of learning the structure when it is modeled for him.

This finding also cautions against concluding about the child's capacities on the basis of his errors alone or on the basis of only a few test items.

Age-relatedness of performance was taken into account, also. It is known that before children begin learning rules of syntax, words are used at a rote-learning level. Irregular verbs may be used at this time without any knowledge on the part of the child of how irregular past-tense forms are generated, or how regular endings are formed, for that matter. Later, however, when the rule for forming the past-tense of regular verbs begins to emerge, the child applies the rule indiscriminately to all classes of verbs. When he applies these regular endings to irregular verbs, we say that the child has "over-generalized" the rule of past-tense formation.

The present research, it was thought, fairly carefully removed the opportunity for rote learning by (1) using a varied list of lexical items and (2) by alternating the observational stimulus items and response stimulus items between regular and irregular verbs. Thus, when the child observed stories containing regular verbs, his task which followed consisted of stories using irregular verbs.

An analysis was performed, however, to check to see if responding was related to verb type. The predictability of responding on the basis of verb type was significant at $p < .001$, with performance confined to regular verbs. This was still true when over-generalization of regular forms on irregular verbs was counted as correct. This is to say, the structure of regular verbs, per se, is related to performance. This, no doubt, is so because the task was to learn the game as presented on

T.V., and the regularities of regular verbs are easier to discern. It is suggested, then, that these same regularities are important as the child observes language in a naturalistic setting. Supportive evidence of this age-relatedness comes from Menyuk (1963) who found that in nursery school children the error of omission of the irregular past-tense forms of verbs and the substitutions of regular endings was significantly greater than among first-graders. A second analysis on this question, which co-varied age, showed that among 5½ - year-olds, responding was significantly related to the verb class, and that the small age differences among these children mattered not at all.

The next few comments no doubt have been anticipated by the prior discussion: differential responding to verb types was related to the Bellugi-type Comprehension. When significant performance levels were reached, it was by Comprehension Ss, and their best performance, in turn, was on regular verbs.

A few years ago, Jenkins (1965) reported some examples of child speech which were clearly generalizations the child himself had made. One of the quotes was the command "... come out and higher the swing." Adult speech would have been something like, "Come out and raise the swing" or, "Come out and lower the swing." It is unlikely that the child had ever heard the construction "...come out and higher the swing," and yet the form, as Jenkins pointed out, was understandable both with respect to meaning and derivation. The conclusion from child language of this sort is that the child generates constructions to meet the situational and grammatical demands. Since the child never hears grammatical forms of this sort the implication is that his construction is analogous to construcitons he has heard, and there is good reason to believe that Ervin-Tripp (1964) was correct in her appraisal of children's ability to "learn by analogy." Learning by analogy further implies that the construction is modeled after speech which the child hears in his environment. The present experimental findings indicate that learning by observation is a practicable process for the child, and may very well be a general technique he uses, but that it is limited to language he understands.

Let me summarize: the Bellugi-type score reflected sentence comprehension, while on the other hand inquiry procedures parceled out actor, action, and object one-at-a-time. The child seems to be able to process the unitary elements when they are presented to him, but the elements in combination, such as the task of the Bellugi test, are more difficult. So, although inquiry-probe procedures are a refinement of measuring the child's comprehension of both syntactic and semantic elements, the grosser measure reflected in the Bellugi score tells us what the child is capable of processing as a string of elements. And what he is capable of processing as a string of elements is what relates to performance on new language learning tasks. Taking account of the Ss' changes in inquiry-comprehension as a result of exposure, revealed no relationship to performance. That is, even though considerable change occurred in these inquiry-probe comprehension scores from initial to final testings, this kind of change was unrelated to learning. And since Bellugi comprehension very definitely was related to learning, we have evidence for two considerably different kinds of comprehension. Therefore, we may state the following:

1. Comprehension of linguistic behavior is a prerequisite to imitation, as defined by social-learning theory, and this comprehension must be of the Bellugi-type; comprehension of sentence elements was unrelated to performance.
2. Prior language productions are not prerequisites to imitative performance.

This second point, together with an earlier discussion of different ways of conceptualizing "imitation", leads to a consideration of the sequential role comprehension plays in language learning and language development. Fraser, Bellugi, and Brown (1963) used a repetition method of studying imitation performance in three-year-olds and their research indicated that, in the acquisition of structures, the capacity to imitate emerges first, followed by the capacity to comprehend, and finally the production capacity develops. Menyuk (1971), however, has pointed out that comprehending and noncomprehending imitation may both occur, depending upon the sentence length and its structure. Ervin-Tripp's data (1964) which indicated that children imitated only what they spontaneously produced also suggests that performance may be related to comprehension. Therefore, it is possible that repetition-imitation is dependent upon comprehension, rather than the other way around, as suggested by Fraser, Bellugi, and Brown.

If one uses the social-learning theory definition of imiation, as the present researcher did, one finds evidence for the sequence as suggested by Menyuk and Ervin-Tripp: comprehension emerges prior to production capacities.

The current state of knowledge in regard to performance and comprehension is summarized in the following quote from Menyuk.

> Answers to questions, "Does the child produce only what he comprehends, or does he comprehend only what he produces?" will lead to a better understanding of the necessary and sufficient conditions for syntax acquisition and, perhaps, provide an explanation of a child's capacities and the techniques that he uses to acquire language.
>
> (Menyuk, 1971, pp. 123-124)

She continues by saying:

> It is important to attempt to resolve questions about the role of imitation in the process of language acquisition, since statements about this role imply assumptions about the nature and functioning of perception, memory, and cognition in the child's acquisition of verbal symbol system as well as about his linguistic behavior. If one assumes that imitation is a necessary step in learning language, and, in fact, must precede comprehension and production of all structures, then one also implies that overt mimicking and practice is the way in which the child learns to understand utterances and to produce them. If one assumes, in addition, that at some later state the child can proceed from imitating utterances to understanding and generating utterances by some system of rules, then one also implies that by rehearsal of phonetic strings, the child either can learn to categorize segments of the utterance into phonetic, morphemic, or syntactic bins and can memorize sequential rules or probabilities, or can derive a system of generalizations from the imitation of a limited number of utterances. The first assumption, memorization of imitations, implies that the child has an infinite memory capacity which operates at a very rapid pace. The second assumption implies that the child has a very large, perhaps also infinite memory capacity, since sequential ordering of a few phones, morphemes, and syntactic classes generate countless permutations and combinations. Both conditions imply that the child acquires a grammar consisting of surface structure rules of how speech sound segments are put together in the utterances heard.

With Menyuk's comments added to this author's observations that there are exiguous data bearing on the Comprehension question, the present research findings are offered as preliminary data for the understanding of the Comprehension factor in language acquisition.

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Models for Performance in Syllogistic Reasoning

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October 1973

Prepared for the

MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH

of the

University of Georgia

Charles D. Smock, Director

PS 011512

This report is based on activities supported by the Mathemagenic Activities Program-Follow Through, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U.S. Office of Education. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

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Preface

Jean Piaget's operational theory of intellectual development has proven a most exciting alternative to behavioristic psychology. The theory emphasizes the qualitative changes in thinking and reasoning processes as the child moves through major stages of development of logical thought. Children are not illogical. The logic of childhood is simply different from the logic of adulthood.

Research to date has confirmed the correctness of the basic phenomena and hypotheses associated with Piaget's theory. Many of these studies, as might be expected, raise more questions than are answered. Such is the case with those studies concerned with differences in the inferential reasoning processes of children and adults. Further, there are sharp theoretical differences on how to explain such processes in adult reasoning.

Models involving imagery and verbalization have been constructed to explain logical processes, but the evolution of computer processing suggests an alternative approach. Specifically, the computer model describes systems in which storage, retrieval, and transformation processes operate and in which symbol manipulation is not dependent upon images derived directly from experience.

Mr. Silverman's study applies the latter approach in order to conceptualize a reasoning strategy employed by adults and extends the approach to an examination of children's strategies. The modeling of strategies adopted in this study is compatible with Piaget's theory, since developmental changes in specific strategies can be related to changes in the more fundamental competency structures associated with each stage.

Though the issues examined here are theoretical, the findings have practical implications for early childhood education. The roles of memory and attention in the relationship of language and thought found in this study suggest some factors which must be considered in instruction. Transitive inferences occur in a wide variety of common experiences in the classroom; for example, activities such as solving mathematics problems with cuisinaire rods, operations on written numbers, lining up from tallest to shortest child, etc. While each of these activities may require some similar cognitive strategies, the teacher can not assume the child will be able to apply the strategy in each case. Differences between the child's abilities to understand information presented verbally (e.g., Johnny is told "A is bigger than B") and nonverbally (e.g., Johnny is shown that A is bigger than B) arise out of the different requirements placed upon his ability to remember. Facilitation of young children's understanding of relational concepts requires careful planning of tasks by taking into account those factors associated with understanding relations, but not intrinsic to understanding; i.e., attention and memory.

C. D. Smock
October, 1973

MODELS FOR PERFORMANCE IN SYLLOGISTIC REASONING[1]

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In the intellectual development of the child, the unfolding of an operational cognitive structure is an important milestone. According to Piaget (1942, 1970) an operational structure consists of actions which are internalizable and reversible, and which are coordinated in lawful systems. Complex invariants are recognized and conserved under a variety of transformations. One example of the existence of such structures is the set of intellectual operations implicit in the thought of children who can seriate, or order, quantities along a continuous scale (Inhelder and Piaget, 1969). The operations here involve a reciprocal function (i.e., they maintain an invariant by coordinating difference relations). For example, the relation $A > B$ is recognized as equivalent to $B < A$. The invariant conserved is the single difference relationship between A and B. Piaget (1965) offers evidence of the necessary development of this structure by noting that most children above seven years of age can arrange rods of varying lengths in a series,

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[1] This paper is based upon a thesis submitted to the University of Georgia in partial fulfillment of the requirements for the M.S. degree and upon a paper presented at the Biennial Meeting of the Society for Research in Child Development, Philadelphia, Pennsylvania on March 29, 1973.

The author wishes to express appreciation to Dr. Charles D. Smock to whom he is indebted for intellectual, moral, and financial support. A thanks is also extended to H. Hale, principal of the Royston Elementary School, Royston, Georgia who graciously supplied subjects, time, and space for this study.

recreate a series, and infer a series when given two asymmetrical relationships (e.g., A > B; B > C, therefore A > B > C and A > C). A child who has not internalized an operational structure, he maintains, is incapable of mastering these tasks.

The Competence Structure

A transitive relation, often presented in the form of a three-item syllogism, involves items whose differences can be arranged along a linear scale in an ordinal manner. For example, height is one dimension along which physical items can be compared and ordered.

Piaget characterizes the mental operations necessary for making such comparisons as "relational thought." In order to operate upon data which is potentially relational, the organism must understand the logical reversibility implicit in the relation. In the two-premise problem requiring transitive inference, S must be able to conceive of two items as existing as a single ideational term (the middle term) which participates both in a single relation with another term (within a premise) and in multiple relations (between premises). The middle term can be both taller than and shorter than simultaneously. It is the development of the ability to structure relational data which allows for an indirect comparison between objects (or ideational terms) which are not contiguous in the series. In a three-term syllogism, the information is given in the form of two propositions, or premises. Because the middle term (B) is established reciprocally with respect to the other terms, the presentation-order of the two premises is logically irrelevant; i.e., A > B; B > C and B > C; A > B represent logically identical series. Similarly, the direction of the relation in each premise is irrelevant: A > B is equal to B < A.

This description of the operational structure underlying transitive reasoning is a model of competence. It is not concerned with the mode of information presentation nor with specific instances to which transitive inference can be applied. Nor does it outline specific interpretive transformational patterns which occur in the actual operating of cognitive structures. Rather, it presents a parametric structure within which a particular organic system operates. This parametric structure is necessary for S to recognize relations apart from the physical attributes of items, and to equate reciprocal relations, but it is not sufficient. While Piaget recognizes that the many characteristics of specific informational events of situations ("demand characteristics") determine whether a competence structure will be applied, he neglects to precisely describe a model of performance. The competence model suggests that organisms, at specific developmental stages, can anticipate the relational outcomes of actions but it does not suggest how S identifies the properties to be seriated nor what specific set of strategic transformations is used to recreate a continuous series from the two discontinuous premises.

The Performance Structure

In order to more precisely predict performance, more detailed models are required. Smedslund (1966) suggests that descriptions of logical structures must involve the microanalysis of intra-individual performances. Klahr and Wallace (1970a) propose that there is no exact relationship between items tapping the same logical aspects of Piagetian concrete reasoning because of internal process differences (which they characterize as attention and motivation).

A model which describes performance in solving three-term syllogisms should allow for identification of elements and relations, encoding and storage of their representations in memory, selective retrieval from memory, operations necessary for identification of a middle term by comparison with retrieved terms, and the decoding of internal representations onto a communicable structure. Such a model describes a transformational system of specific strategies functioning within the constraints of the operational structure. Recent studies of cognition have attempted to outline the general nature of such models, taking into account the digital and serial character of information processing both at the physiological and psychological levels (Ashby, 1963; Hebb, 1968; Hunt, 1971; John, 1967; McCulloch, 1965; Newell and Simon, 1963; Trabaso, Rollins, and Shaughnessy, 1971).

The present study made use of an analytic strategy which distinguished between operational competence -- the existence of the structure outlined above-- and operational performance -- the strategic application of this structure in specific instances. The approach makes a distinction similar to that between "metaplan" and "plan" proposed by Miller, Galanter, and Pribram (1960). Here, a metaplan is described which is implicit in the operation of the system. It is suggested that operational performance can be characterized in terms of a model of state-transitions.

Adult's Transitive Inferences from Verbal Presentations

Three-term syllogisms can be presented in one of several input modes: visual, verbal, and tactile. Theoretically, a performance model for transitive inference can imply that differences in the functional requirements of data configurations determine some performance differences between these two modes of problem presentation, but that the functions which enable S to identify the series itself are basically identical across modes (i.e., a single competence model for the underlying operational system). A strategy can be viewed as consisting of two logical units: A within-premise, or explicit logic (e.g., $A > B$ and $B < A$), and a between-premise, or implicit logic ($A > B; B > C$), involving the identification of B as a middle term. Given the assumption of a single competence structure within an individual, differences between input modes (visual, verbal, and variations of their forms) could have an immediate effect on the types of within-premise transformations. The fundamental logic involving between-premise comparison could, however, remain invariant across presentation modes, for example, when non-verbal variables which tend to distinguish verbal from concrete presentation modes are controlled.

Current proposals for performance models for transitive inference suggest that the between-premise functions are either language - (Clark, 1969) or "spatial imagery" - specific (Huttenlocher, 1968). These proposals suggest that the specific form of internal symbolic representation influences the between-premise logic involved in discovering the middle term of transitive syllogisms. Both theories were designed to apply directly to verbal syllogisms. The contra-intuitive findings that non-linear premise-orders of verbal syllogisms are more easy to understand than are linear premise-orders (where "ease" is measured by the percent of correct inferences and by the response latencies of those inferences) are considered by both proposals. For example, given three ordered terms, $A > B > C$, the premise-order $A > B; B > C$ is more difficult to interpret than the premise-order $B > C; A > B$. However, evidence for this phenomenon is lacking in the concrete mode.

Clark (1969) loosely interprets Donaldson (1963) in his proposal that a strategy of "information compression" accounts for the premise-order results. In the non-linear sequence, "John is better than Bill; Dick is better than John," Clark (1969) proposes that the first premise is stored as, "John is good+" (i.e., John is the better one). Presentation of the second premise produces the following reasoning: "Since Dick is better than John, who is already the better one, then Dick is best, John next, and the other one least good (Clark, 1969, p. 397)." In the linear presentation, however, there can be no obvious series deduced after compression of the first premise. Clark offers no precise explanation that describes the process by which the linear premise-order is analyzed as a series.

Huttenlocher (1968), proposing a theory of spatial imagery based, in part, on the investigations of DeSoto, London, Handel (1965), suggests that "for relational statements, S̲s apparently assign the role of actor to the grammatical subject, even though this term does not describe an actor in the usual sense (p. 554)." According to her, the problem-solver arranges the first premise in an imaginary "spatial array" and "manipulates" the mobile actor (equivalent to the "logical subject") of the second premise, which is, of course, the grammatical subject, placing it in the array. Huttenlocher supports this theory both in terms of the introspections of subjects, and evidence of grammatical subject -- logical subject equivalence in block arrangement tasks administered to children (Huttenlocher and Strauss, 1968).

Assuming that adult reasoning is facilitated by similar processes, she proposes that the notion of "logical subject" coupled with "spatial imagery" accounts for the premise-order effect. In the premise-order B > C; A > B, the individual assigns B̲ and C̲ in the first premise to positions on an imaginary scale, and then "places" A̲ in the appropriate relative position on the scale. In the alternative premise-order A > B; B > C, if A and B are placed on the scale, the "logical subject" of the next premise is B. Placing B on a scale, which already includes B as one of the two items, adds no additional information and makes analysis of the syllogisms more difficult. Huttenlocher, like Clark, does not offer an explanation that specifically describes how the second (the linear) sequence is solved at all. In her theory, linguistic information contained in adjectives plays only a within-premise role prior to the process of mapping the information into a spatial array.

Huttenlocher describes an abstract logical paradigm potentially analogous to a general mode of transitive reasoning proposed here:

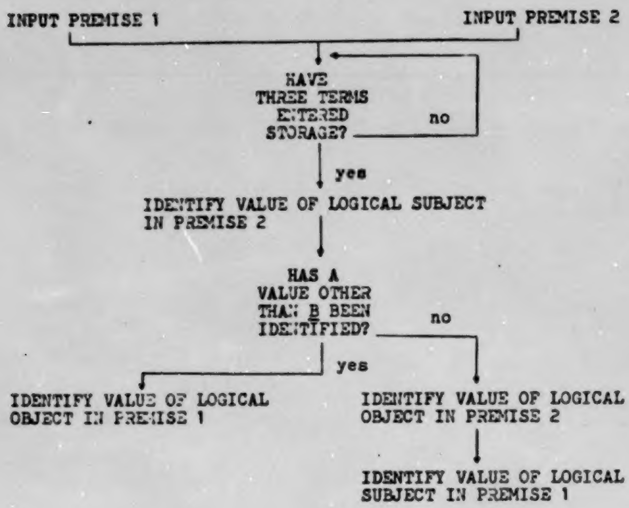
> . . . one could simply postulate that Ss order the set of three items by determining from the second premise the relation of the "new" item to the "old" item, while remembering at the same time that the "old" item is itself ordered with respect to yet another item (Huttenlocher and Higgens, 1971, p. 498).

This imagery-independent model is rejected, however (Huttenlocher and Higgens, 1971). Recognition of B as a dual-functioning item is common to both the Huttenlocher and the Clark performance models. But in Clark's theory, recognition of the grammatical role of the "new" item in a system of verbal inference explains the linear-nonlinear premise-order performance effects whereas Huttenlocher's theory requires that a logical subject, or actor, be identified and its image moved in a system of spatial inference.

Each interpretation appears to have its drawbacks. Clark's model, as it stands, proposes that, in identifying the series, verbal reasoning operations transform linguistic terms or features at the between-premise level. This performance model is input- and representation-specific. Huttenlocher's model can be interpreted as not input-specific, but it employs placement in imaginary space to predict performance. The problem of explaining the processes underlying the imagery processes, however, remains. It is these underlying processes themselves which determine performance.

Figure 1

Series Identification Strategy[a]


INPUT PREMISE 1
INPUT PREMISE 2
HAVE THREE TERMS ENTERED STORAGE?
no
yes
IDENTIFY VALUE OF LOGICAL SUBJECT IN PREMISE 2
HAS A VALUE OTHER THAN B BEEN IDENTIFIED?
no
yes
IDENTIFY VALUE OF LOGICAL OBJECT IN PREMISE 1
IDENTIFY VALUE OF LOGICAL OBJECT IN PREMISE 2
IDENTIFY VALUE OF LOGICAL SUBJECT IN PREMISE 1

---

[a] For example, in the syllogism $A > B_1$; $B_2 > C$,

A = logical subject of premise 1
B_1 = logical object of premise 1
B_2 = logical subject of premise 2
C = logical object of premise 2

and in the syllogism $B_1 > C$; $A > B_2$,

B_1 = logical subject of premise 1
C = logical object of premise 1
A = logical subject of premise 2
B_2 = logical object of premise 2

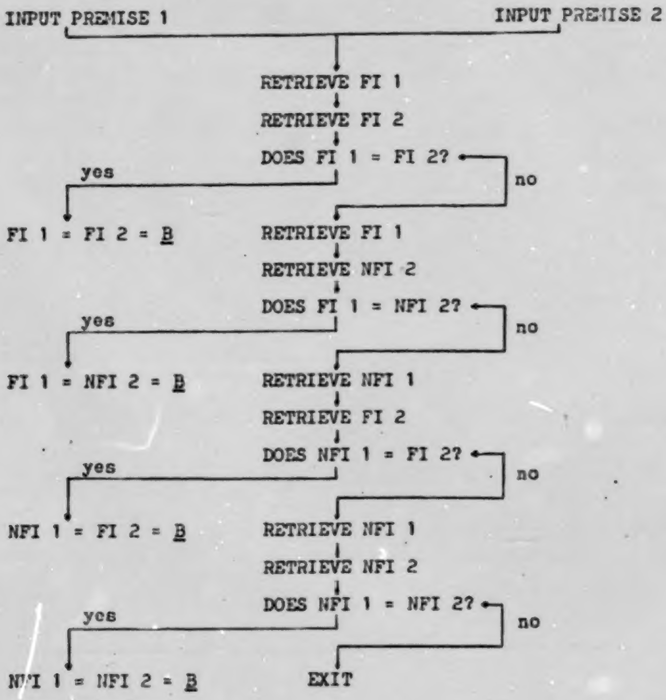
Figure 1 illustrates the application of a Huttenlocher-type model to analysis of two-premise, three-term syllogisms, regardless of the mode of input. This interpretation replaces the notion of imagery with an information processing sequence which accounts for premise-order effects. This performance model is not intended to account for effects due to question-type, or to the particular comparatives used in the verbal presentation mode. As in Huttenlocher's original model, identification of the middle term is assumed. Identification of the "logical subject" in premise two plays a key role in determining the premise-order effect. In the verbal mode of input, a logical subject of a relational statement is a grammatical subject. A logical subject potentially is also an actor. For example, in a concrete presentation of a three-term syllogism, in which rods of three different heights are compared in separate premises, a rod which is moved to facilitate a comparison between it and another rod could take on the role of an actor and be processed as such. In this situation, a premise-order effect would be expected to appear, with mobility defining "logical subject."

Alternatively, it is possible that "logical subject" is a misnomer. It may be that the grammatical subject of a verbal premise simply becomes an item of focal attention (hereafter referred to as "Focus Item") in relational statements and is therefore more easily retrieved. In statements in which there is an actor represented (e.g., "John hits Bill"), the actor (i.e., the one who hits) might also be the grammatical subject. There is evidence that when these two potential focus items (actor and grammatical subject) conflict (e.g., "Bill is hit by John") the statement becomes more difficult to interpret (Slobin, 1966). In a concrete presentation it is possible that a focus item might involve a factor other than activity. For example, height might influence attention, and S would treat the tall item of a premise as a focus item. In this latter case, the terms "logical subject" and "logical object" of Figure 1 would be replaced by "focus item" (FI) and "non-focus item" (NFI). This model maintains, then, that the premise-order effect is the outcome of a strategy which involves differential numbers of comparison functions in the identification of the entire series.

At least one alternative non-specific input and representation performance model can be postulated. While Huttenlocher's model is based on a process which takes place after the middle term has been identified, it is equally possible to describe a model which accounts for premise order effects by characterizing the means by which the middle-term (B) itself is identified. Remember that in a three-term syllogism, two B's are presented: one B item in each premise. From these two items, a single term must be synthesized. Both Clark and Huttenlocher characterize this synthesis as relatively insignificant in light of other strategic processes. However, the competence structure depicted emphasizes the capacity of S to recognize that B can participate in two relations simultaneously and still retain the identify of B as a single term. Given this interpretation of the competence requirement, the synthesis of B from two separate inputs may be of more importance in a performance model than Huttenlocher suggests. While Figure 1 offers a description of a "Series Identification Strategy" (SIS), a "Middle Term Identification Strategy" (MIS) offers an alternative possibility.

Figure 2

Middle-Term Identification Strategy[a]


INPUT PREMISE 1
INPUT PREMISE 2
RETRIEVE FI 1
RETRIEVE FI 2
DOES FI 1 = FI 2?
yes
no
FI 1 = FI 2 = B
RETRIEVE FI 1
RETRIEVE NFI 2
DOES FI 1 = NFI 2?
yes
no
FI 1 = NFI 2 = B
RETRIEVE NFI 1
RETRIEVE FI 2
DOES NFI 1 = FI 2?
yes
no
NFI 1 = FI 2 = B
RETRIEVE NFI 1
RETRIEVE NFI 2
DOES NFI 1 = NFI 2?
yes
no
NFI 1 = NFI 2 = B
EXIT

---

[a] For example, in the syllogism $A>B_1$; $B_2>C$,
A = FI 1, B_1= NFI 1, B_2= FI 2, C = NFI 2,
and in the syllogism $B_1>C$; $A>B_2$,
B_1= FI 1, C = NFI 1, A = FI 2, B_2= NFI 2

This alternative strategy (see Figure 2) assumes that latencies associated with identification of the series are not influenced greatly by premise-order, but that latencies reflecting identification of the middle-term are influenced by premise-order. The middle-term is defined here as the term which appears twice. S uses the focus item of the first premise as a referent and begins a series of comparisons in order to identify B. First, there is a comparison of the focus item of the first premise (FI_1) with that of the second premise (FI_2). FI_1 is compared with the non-focus item of the second premise (NF_2). The non-focus item of the first premise (NF_1) may be selected as a new referent and the search is continued. However, this latter tactic is not crucial to the predictive value. In the case of premise-order B/C; A/B only two comparisons are necessary to find a match. In the case of A/B; B/C at least three, and possibly more, are necessary to discover a match. The MIS strategy, like SIS, is not intended to account for the entire decision process between input and output: the influence of question--type, negative equative verb forms, and marked and unmarked comparative forms is not examined in this analysis.

Both SIS and MIS are models for searching memory stores, comparing retrieved items, and proceeding to a next step based on the outcome of the previous comparison. In both models, memory searches are determined by a search-strategy in which FI (focus item) or LS (logical subject) is more accessible than NFI (non focus item) or LO (logical object) during input and, therefore, is preferentially retrieved. Both models assume a competence structure which enables S to define the end-point of the strategy (goal) to be the reconstruction of a series of three terms from two premises. In addition, each model assumes that the entire series is identified prior to the analysis of the question, and that one transformation at a time is processed.

Experiment Design I

In order to ascertain whether, in fact, a single non-specific input performance model (e.g., SIS or MIS) can account for between-premise solution strategies, an experiment was designed to introduce variables typically occurring in both the verbal and the concrete presentation modes. Separately presented premises were constructed that had the potential for maintaining a distinction between logical subject/focus item and logical object/non-focus item as control variables in order to induce a premise-order effect. Evidence of premise-order effects in the concrete mode, attributable to the function of the middle-term in the second premise (e.g., moved item or tallest item), would suggest that a single analytic strategy occurs in both linguistic and concrete problem solutions. Thus, performance strategies would appear not to be accounted for by language-specific variables (as Clark suggests) and pure linguistic model would be inadequate in accounting for the between-premise logic occurring in verbally presented relational problems.

In addition, the design allowed for a distinction between the applicability of "logical subject" (defined by action) and "focus item" (defined as any salient feature, such as tallness) in either the Series Identification Strategy (SIS) or a Middle-term Identification Strategy (MIS).

Children's Inferences from Verbal and Concrete Presentations

While both the verbal and the concrete forms of problem-presentation require an operational structure for transitive inference, previous studies suggest that children in the concrete operational stage (7 to 11 years) are unable to make transitive inferences from verbally presented premises (Burt, 1919; Donaldson, 1963; Piaget, 1921, 1969) but can make inferences from concrete premises (Piaget, Inhelder, and Szeminska, 1960; Smedslund, 1963). Clinical interviews with Ss (Donaldson, 1963; Piaget, 1921) suggest that when presented with two-premise verbal syllogisms they tend to interpret the referenced items as possessing absolute rather than relative qualities.

The experimental approach in the area of concrete transitivity began as an attempt to verify Piaget's notion of competence stages and of age of stage-onsets (Braine, 1959, 1964; Piaget, Inhelder, and Szeminska, 1960; Smedslund, 1963, 1965). More recent research examined performance strategies (Bryant and Trabasso, 1971; Riley and Trabasso, 1973; Rooding and Gruen, 1970; Youniss and Murray, 1970). These letter studies indicate that if performance factors relevant to retention of input are reduced or eliminated, children younger than seven years are able to solve syllogisms in the concrete form.

Two other studies suggest that memory processes influence the ability of concrete operational children to make transitive inferences. Odom and Coon (1967) and Glick and Wapner (1968) find that many children at the concrete operational stage are able to make transitive judgments from verbal premises when the influence of memory loss is diminished through training or presentation procedures in which Ss are told to memorize each premise (Odom and Coon) or in which memory aids are used (Glick and Wapner).

It may be that the differences in the ability to make inferences from concrete and from verbal presentations are due to differences between the requirements placed upon immediate memory in each of the two modes of presentation. If such is the case, a question similar to that examined in

Experiment Design I might be posed: Is the difference in ages at which children can make transitive inferences from verbal and from concrete problems due to variables which are inherently language-specific? Or is it due to those variables which are only typically present when language is used and typically absent when problems are presented with concrete materials? Results from the concrete and verbal modes of presentation suggest that concrete operational children may possess competence structures inadequate to identify and store relevant input, but sufficient to allow for transformational inferences from information already in memory storage.

Experiment Design II

It seems possible that the strategies of children are, to a large extent, not intrinsically input-specific, and that strategies based upon storage, retrieval, and comparison processes influence performance. If it is postulated that in the traditional verbal three-term syllogism (in which no memory aids are used) storage and/or retrieval processes depend upon recognition of relevant data to be stored and/or retrieved, and that children in the concrete operational stage are incapable of representing the abstract criteria necessary to recognize problem format, then the relative difficulty in solving verbal problems (compared to concrete problems) can be explained. In cases in which additional aides in identifying and retaining relevant information are used in presenting concrete problems, inferential difficulty tends to decrease.

At the stage of concrete operations, two-premise, three-term verbal and concrete syllogisms (identical to those referred to in Experiment Design I) should be difficult for children to solve when memory storage is not facilitated. The expectation was that children, who had demonstrated transitive inference in solving traditional concrete syllogisms in which all items to be compared were simultaneously present, would exhibit performance decrements (increased error frequencies) when administered verbal and concrete two-premise syllogisms in which all items were not simultaneously present. Furthermore, it was expected that error-types would reflect a strategy in which only the last premise is interpreted. Such a strategy would result from the inability of S to spontaneously store and retrieve relational information contained in the first premise.

Method

The same sets of concrete and verbal problems were administered to two groups of Ss: one group of adults, and one of children aged 7 years 10 months to 8 years 10 months, with a mean age of 8 years 2 months.

Adults

In the adult group 28 Ss were presented with 24 pre-recorded verbal three-term syllogisms of the general form A > B; B > C, each followed by a single question, also on tape: "Who is tallest?" or "Who is shortest?". Premise-order (e.g., A > B; B > C vs B > C; A > B), grammatical subject and object and the relevant comparative term (taller or shorter), and question-type (e.g., T? vs S?) were varied. Each S was given three pre-recorded practice problems. No name was used more than once in the entire group of 24 problems. Decision latencies were automatically recorded by a timer actuated at the conclusion of each question and stopped by a voice-sensitive trigger.

A second group of 28 adults was presented with 24 concrete syllogisms, each followed by a single verbal question. As in the verbal mode, each syllogism consisted of two separate premises relating three items. Items in the concrete mode, however, were wooden rods. Each S was shown a vertical tray upon which E presented and moved pairs of rods differing in height by .2 inches. Accurate comparison of the heights was impossible until E slid one rod to a position beside the other, as he stood behind the tray, facing S. Three practice problems were given. Rods were distinguishable by their colors: yellow, green, and blue. Ss were told and shown that several sets of rods were being used and that color was not related to height. Concrete premises were presented separately. In the first premise, two wooden rods were simultaneously placed on the tray, compared, and removed simultaneously. The second premise was presented in an identical manner. The middle item of the series was presented in both premises, of course. Therefore, S saw one rod twice during each problem presentation. Separate presentation of premises and the removal of the rods used in the second premise prior to questioning replicated the transcience typical of the verbal mode. Following the presentation of the two premises, a single question was asked: "Which is tallest?" or "Which is shortest?". As in the verbal mode, premise-order and questions were varied. The rod which was actually moved in each premise was also varied. This latter variable was controlled with the intent of determining whether S made use of a "logical subject" (as defined by action of the item). Decision latency was ascertained in a manner similar to that used in the verbal treatment.

Children

In the child group, Ss were selected on the basis of successful performance on a three-problem pretest of concrete transitivity. In this pretest, all three rods were presented simultaneously, rather than in two completely separate premises. In general, the pretest presentation format was similar to that used by Smedslund (1963). A Mueller-Lyer illusion, however, was not used. The small heights between rods necessitated the application of transitive inference for consistently correct solutions. The criterion for S selection was success on two of the three problems. A total of 56 Ss were selected in this manner, and were presented with either verbal or concrete syllogisms identical to those administered to the adult group.

Results

Non parametric significance tests using ordinal information were employed.[2]

Adult Performance

In the adult group, latencies of correct responses to problems were examined. A combined mean latency was ascertained for each problem-type for the two questions "Who/Which is tallest?" and "Who/Which is shortest?".

Concrete presentations

In the concrete mode, the presence of premise-order and logical subject effects, similar to those found by Clark and by Huttenlocher in the verbal mode, was examined. Two possibilities were considered: (1) that the "logical subject" in the concrete premise is defined by S as the active rod, the rod which is moved to facilitate comparisons; or (2) that the "logical subject" is more aptly called a "focus item" and is the rod which is the tallest within a premise.

(1) Logical subject as mobile rod:

The possibility of a premise-order effect based on the assumption that movement causes within-premise differences and thus influences linearity was first examined. Difference between A > B and B < A were defined in terms of movement rather than language. For example, in the premise characterized as A > B, A is the rod which is actually moved to B. Latencies for two pairs of problems with identical premises, but different orders, are compared. Table 1 indicates no premise-order effect ($p > .05$).[3]

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[2] An adjusted p-value of .0018 was estimated to hold at .05 on an errors per experiment basis. However, probability of a Type 2 error was judged to be high and this rather stringent criterion for significance was not employed in hypothesis tests.

Table 1

Mean Reaction Times for Linear Versus Nonlinear Premises for Adults

Problem[a]			n	MRT[b]
Linear:				
1	A moves to B;	B moves to C	(17)	132
2	C moves to B;	B moves to A	(25)	114
Nonlinear:				
1	B moves to C;	A moves to B	(17)	102
2	B moves to A;	C moves to B	(25)	114

pair 1 x 1: $p > .05$, Wilcoxen
pair 2 x 2: $p > .05$, Wilcoxen

[a] matching numbers at extreme left indicate pairs compared
[b] in centiseconds

A statistical analysis of latencies for the middle item (B) as a mobile item and for the end-item as a mobile item in the second premise also revealed no significant differences (Table 2; $p > .05$).

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[3] The Wilcoxen Signed Ranks Test was applied in all comparison not otherwise indicated.

Table 2

Mean Reaction Times for End-item Versus Middle-item as Mobile in Second Premise for Adults

Problem[a]	n	MRT[b]
End-item as mobile item (2nd prem)		
1 A moves to B; C moves to B	(16)	120
2 C moves to B; A moves to B	(21)	100
3 B moves to C; A moves to B	(19)	100
4 B moves to A; C moves to B	(20)	120
Middle-item as mobile item (2nd prem)		
1 A moves to B; B moves to C	(16)	132
2 C moves to B; B moves to A	(21)	110
3 B moves to C; B moves to A	(19)	100
4 B moves to A; B moves to C	(20)	120

pair 1 x 1: $p > .05$, Wilcoxen
pair 2 x 2: $p > .05$, Wilcoxen
pair 3 x 3: $p > .05$, Wilcoxen
pair 4 x 4: $p > .05$, Wilcoxen

[a] matching numbers at extreme left indicate pairs compared
[b] in centiseconds

(2) Logical subject as taller rod:

The potential differential influence of height, inrrespective of movement, was then examined. If S attends to "tallness", then in the premise A > B, A is a "focus item" regardless of the rod which is moved to facilitate comparisons of height. The two premise-orders compared were A/B; B/C and B/C; A/B. Analysis yielded a significantly shorter latency in the B/C; A/B condition (Table 3; $p < .005$).

Table 3

Mean Reaction Times for End-item as Tallest Versus Middle-item as Tallest in Second Premise for Adults

Problem	n	MRT[a]
B/C; A/B	(26)	109
A/B; B/C	(26)	119

$p < .005$, Wilcoxon

[a] in centiseconds

Verbal presentations

The analysis of data indicated no premise-order effect in the verbal mode ($p > .05$). Table 4 contrasts the results of this study with those of Clark (1969).

Table 4

Mean Reaction Times for Linear Versus Nonlinear Premises for Adults

Problem[a]	Clark n	Clark MRT[b]	Silverman n	Silverman MRT[b]
Linear				
1 A taller B; B taller C	(13)	575	(13)	210
2 C shorter B; B shorter A	(13)	640	(12)	162
Nonlinear				
1 B taller C; A taller B	(13)	525	(13)	186
2 B shorter A; C shorter B	(13)	547	(12)	174

Clark: $F = 17.56$,
$df = 1/52$
$p < .001$

Silverman: pair 1 x 1: $p > .05$, Wilcoxen
pair 2 x 2: $p > .05$, Wilcoxen

[a] matching numbers at extreme left indicate pairs compared
[b] in centiseconds

A statistical analysis comparing latencies for the middle term (B) as the grammatical subject in the second premise with those of the end-item as grammatical subject also revealed no significant differences ($p > .05$). Table 5 contrasts these results with those of Huttenlocher (1968).

Table 5

Mean Reaction Times for End-item as Subject Versus Middle-item as Subject in Second Premise for Adults

Problem[a]	Huttenlocher n	Huttenlocher MRT[b]	Silverman n	Silverman MRT[b]
End-item as subject (2nd prem)				
1 A taller B; C shorter B	(48)	141	(10)	264
2 C shorter B; A taller B	(48)	142	(6)	108
3 B taller C; A taller B	(48)	135	(11)	264
4 B shorter A; C shorter B	(48)	142	(6)	264
Middle-item as subject (2nd prem)				
1 A taller B; B taller C	(48)	155	(10)	336
2 C shorter B; B shorter A	(48)	161	(6)	265
3 B taller C; B shorter A	(48)	157	(11)	270
4 B shorter A; B taller C	(48)	157	(6)	208

Huttenlocher: $p < .01$, Wilcoxen

Silverman: pr 1 x 1: $p > .05$, Wilc.
pr 2 x 2: $p > .05$, Wilc.
pr 3 x 3: $p > .05$, Wilc.
pr 4 x 4: $p > .05$, Wilc.

[a] matching numbers at extreme left indicate pairs compared
[b] in centiseconds

These disparate findings probably can be attributed to methodological differences and will be discussed in a later section of this paper.

Adults tended to perform better ($p < .00003$) on concrete (Mean = 22.43) than on verbal presentations (17.20) as determined by the Mann-Whitney U-test.

Child Performance

A criterion of error for transitive inference based on a 95% confidence interval for correct solutions by adults was established for the analysis of the child data. To be judged as having made a transitive inference in the concrete mode, an S was permitted no more than two errors. In the verbal mode, an S was permitted no more than nine errors. Only one out of 28 Ss reached criterion in the concrete presentation, and no children reached the established criterion in the verbal presentation.

The possibility that Ss were answering the question with reference to only the elements of the second premise then was examined.

Concrete presentations

With the criterion that 80% of S's answers conform to the predicted second-premise strategy, analysis of responses to the questions "Which is tallest?" and "Which is shortest?" revealed that 17 Ss or 61%, in the concrete mode, indicated results congruent with this proposed strategy. Table 6 presents the relevant data for the group as a whole. There are large differences in the number of correct responses between problems in which answers are appropriate to a second as compared to a first premise strategy ($p < .01$).

Table 6

Percentage of Correct Answers in Second Versus First Premise for Children[a]

Correct answer in second premise		Correct answer in first premise	
Item[b]	%	Item[b]	%
Question: "Which is tallest?"		Question: "Which is tallest?"	
1 B moves to C; A moves to B	79	1 A moves to B; B moves to C	21
2 C moves to B; B moves to A	86	2 B moves to A; C moves to B	36
3 C moves to B; A moves to B	89	3 A moves to B; C moves to B	39
4 B moves to C; B moves to A	82	4 B moves to A; B moves to C	29
Question: "Which is shortest?"		Question: "Which is shortest?"	
5 A moves to B; B moves to C	82	5 B moves to C; A moves to B	39
6 B moves to A; C moves to B	68	6 C moves to B; B moves to A	43
7 A moves to B; C moves to B	75	7 C moves to B; A moves to B	32
8 B moves to A; B moves to C	61	8 B moves to C; B moves to A	39
mean :	78	mean :	35

$n = 8$, $p < .01$, Wilcoxen

[a] Problems with B responses as correct answers were not included since the premise to which a B referred was indeterminate

[b] Each item represents results from two problems; matching numbers at extreme left indicate pairs compared

Verbal presentations

Analysis of performance of individuals under the verbal mode revealed no Ss consistently adopted a second-premise strategy (i.e., no S met the 80% criterion). Analysis of performance of the combined group data, however, suggested a second-premise strategy is partially adopted by Ss. Table 7 indicates there are significant differences in the number of correct answers between problems in which answers are appropriate to the second as compared to those in which answers are appropriate to the first premise ($p < .01$).

Table 7

Percentage of Correct Answers in Second Premise Versus First Premise for Children[a]

Correct answer in second premise		Correct answer in first premise	
Item[b]	%	Item[b]	%
Question: "Who is tallest?"		Question: "Who is tallest?"	
1 B taller C; A taller B	25	1 A taller B; B taller C	21
2 C shorter B; B shorter A	43	2 B shorter A; C shorter B	18
3 C shorter B; A taller B	58	3 A taller B; C shorter B	36
4 B taller C; B shorter A	29	4 B shorter A; B taller C	7
Question: "Who is shortest?"		Question: "Who is shortest?"	
5 A taller B; B taller C	39	5 B taller C; A taller B	29
6 B shorter A; C shorter B	46	6 C shorter B; B shorter A	36
7 A taller B; C shorter A	25	7 C shorter B; A taller B	29
8 B shorter A; B taller C	39	8 B taller C; B shorter A	14
mean :	38	mean :	24

$n = 8$, $p < .01$, Wilcoxen

[a] Problems with B responses as correct answers were not included since the premise to which B referred was indeterminate

[b] Each item represents results from two problems; matching numbers at extreme left indicate pairs compared

The possibility that congruence between the verbal comparatives of the first and second premises influenced Ss use of the second premise as a source of answers was considered. However, a test comparing the number of correct responses in the second premise in problems with congruent comparatives to the number of correct responses in the second premise in problems with incongruent comparatives yielded no significant differences (Table 8; $p > .05$).[4]

Table 8

Correct Responses with Answer in Second Premise for Congruent Versus Incongruent Comparatives for Children

Comparative Type	Mean[a]
Congruent	
A taller B; B taller C	1.61
B taller C; A taller B	
B shorter A; C shorter B	
C shorter B; B shorter A	
Incongruent	
A taller B; C shorter B	1.64
C shorter B; A taller B	
B shorter A; B taller C	
B taller C; B shorter A	

$p > .05$, Friedman test

df = 1

[a] Out of 4 possible correct answers

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[4] A Friedman Two-Way Analysis of Variance by Ranks was used. Matched pairs (required by the Wilcoxen Test) were inappropriate.

The possibility that congruence between the question-type and the verbal comparative in the first premise might dominate a second-premise strategy also was considered. For example, in problems in which the question is congruent with the first premise, S might select either the first premise (because it is congruent) or the second premise (because it is recent). In problems in which the question is not congruent with the first premise, the second premise might be the dominant influence. Table 9 suggests that Ss more frequently answer as if only the second premise contained information appropriate to problem solution when the first premise is not congruent with the question.

Table 9

Influence of Congruence Between Premise and Question on the Distribution of Responses of Children[a]

Premise 1	Premise 2	Answers appropriate to premise 2 (%)	Answers naming middle item (%)	Others (%)
C	C	37.5	42.8	19.6
C	NC	33.9	41.1	25.0
NC	C	41.1	41.1	17.8
NC	NC	41.1	28.6	30.0

C = Premise comparative is congruent with question asked
NC = Premise comparative is not congruent with question asked
Others = Answers inappropriate to either the first or second premises

[a] Only problems followed by "Who is tallest?" and "Who is shortest?" questions were considered. Total for each row equals 100.

However, further analysis (Table 10) indicates the difference is not consistent across problem-types and, accordingly, is not significant ($p > .05$).

Table 10

Percentage of Correct Answers in Second Premise when First Premise is Incongruent with Question Versus when First Premise is Congruent with Question for Children[a]

First premise incongruent				First premise congruent			
	Item[b]		%		Item[b]		%
	Question: "Who is tallest?"				Question: "Who is tallest?"		
1a	C shorter B;	B shorter A	64	1a	B taller C;	B shorter A	51
1b	C shorter B;	B shorter A	21	1b	B taller C;	B shorter A	50
2a	C shorter B;	A taller B	57	2a	B taller C;	A taller B	42
2b	C shorter B;	A taller B	57	2b	B taller C;	A taller B	14
	Question: "Who is shortest?"				Question: "Who is shortest?"		
3a	A taller B;	C shorter B	36	3a	B shorter A;	C shorter B	57
3b	A taller B;	C shorter B	14	3b	B shorter A;	C shorter B	36
4a	A taller B;	B taller C	43	4a	B shorter A;	B taller C	14
4b	A taller B;	B taller C	36	4b	B shorter A;	B taller C	64
		mean :	41			mean :	35

$n = 8$, $p > .05$, Wilcoxen

[a] Problems with B responses as correct answers were not included since the premise to which a B referred was indeterminate

[b] Each item represents results from a single problem; matching numbers at extreme left indicate pairs compared

It appears that a second-premise strategy, based on a strategy of retrieval arising from a recency principle, in which the second premise is positively weighted for retrieval, operates in both the verbal and concrete modes.

Two other trends were noted in the verbal mode. Children recalled the middle term as often as terms appropriate to the second premise. Ss recalled items not appropriate to a second-premise strategy, or to a middle-term recall strategy second in frequency. For example, in the syllogisms "A > B; B > C. Who is tallest?" and "C < B; B < A. Who is shortest?", S̲s selected the terms C̲ and A̲ (respectively) 19.6 times out of 100 answers. No S̲s, however, met a criterion that 80% of their answers correspond to a defined strategy. These trends, as well as the previously described second-premise trend, are not employed exclusively by a particular subject, but rather, the strategies are used in combination.

Children, as well as adults, tended to perform better on concrete presentations than on verbal presentations ($p < .00003$).[5] The mean number correct for children was 12.41 (concrete) and 8.18 (verbal).

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[5] A Mann-Whitney U-Test was used. Error frequencies were compared across independent groups of S̲s.

Discussion

Adult Performance

The adult data suggest three conclusions: (1) a linguistic strategy which accounts for premise-order differences in the verbal mode might be replaced by a sublinguistic strategy which is equally applicable to the premise-order differences in the concrete presentation mode; (2) a model which requires that "logical subjects" be equated with "actors" in order to be identified and transformed is not applicable to solutions in the concrete mode in which height, not mobility, appears to play a role in determining premise-order effects; (3) a sublinguistic strategy, which incorporates FI's in determining relations between elements, may take the form of series-identification or middle-term identification strategies.

A model in which the concept of "logical subject" is replaced by a concept of "focus item" which can be either the grammatical subject of a premise in the verbal mode, or the tallest item of a premise in the concrete mode, is proposed. In Figure 1, then, "Logical Subject" (LS) is replaced by "Focus Item" (FI), and "Logical Object" (LO) is replaced by "Non-Focus Item" (NFI). This model maintains that the premise-order effect is the outcome of a strategy which involves differential numbers of comparison functions in the identification of the entire series. The Series Identification Strategy (SIS) of Figure 1 assumes that identification of the middle-term is either of minor functional importance or that latencies associated with identification of the middle-term are not influenced by premise-order.

It is equally possible, however, that the premise-order effect is attributable to a differential number of comparison functions employed in an attempt to identify two separate items as a single middle-term. This second possibility is represented in Figure 2. MIS incorporates a notion of FI in accounting for the form a strategy takes.

As previously noted, order of retrieval differs between the SIS and MIS models. Order of premise retrieval in the *SIS* model is determined by a push-down store postulated in other models of memory (Bower, 1970; Klahr and Wallace, 1970b; Yngve, 1960). Items needed to complete a three-item series are identified first in premise two, *then* in premise one (*recency principle*). Order of item retrieval within premises is not governed by a push-down store. Though FI's probably enter memory before NFI's (within a single premise), FI's are retrieved prior to NFI's (*attention principle*). Thus FI 2 is retrieved prior to NFI 2. Order of retrieval of premises supersedes order of retrieval of items within premises. Since premise two enters last, the NFI of premise two is retrieved before the FI of premise one.

MIS employs an open-ended store with respect to order of premise retrieval. Premise one, the first premise encoded, is also the first premise retrieved (*primacy principle*). As in SIS, FI's are retrieved prior to NFI's (*attention principle*). But in MIS, FI retrieval supersedes premise retrieval. Thus FI 1 and FI 2 are retrieved first and compared. And since FI's are more easily retrieved than NFI's, the FI of premise one is retrieved before the NFI of premise two. SIS assumes a storage location in which three cells must be filled (one cell for each seriated item) and a memory which determines a search strategy by noting that a cell has been filled, preventing a later search for the value associated with that cell. MIS assumes a storage location in which only a single cell must be filled (a cell for the middle-term) and a memory that determines the search strategy by noting the comparisons which have already occurred.

Although this study does not empirically distinguish between MIS and SIS, they are potentially distinct. SIS predicts that in a two-premise syllogism in which the middle-term appears only once, as a single item (rather than as two separate items), the premise-order effect should continue to occur. MIS predicts that the premise-order effect should disappear in such a design, since the middle-term would not have to be reconstructed from two separate items.

Unlike the Huttenlocher data which shows a direct relationship between mean response latency and mean number of errors for a specific problem-type, no relationship between error frequency and premise-order in either the concrete or verbal modes of presentation were found in the present study. The very small number of errors made by adults presented with problems in the concrete mode (1.65 errors, s = ± .658, out of 24 problems) made analysis of error-frequency across variables meaningless. In the verbal mode, where 6.70 errors were made (s = ± 2.50), such an explanation does not hold. While Huttenlocher's Ss' responses resulted in roughly 14% errors, the Ss in this study averaged 28% errors. This difference can be attributed to the increased memory load placed on the Ss. It may be that while the latencies of correct responses result in information which reflects analytic strategy, error frequency data tended to reflect errors in the recall of names used, rather than errors in analyzing relations between names. This interpretation is supported by the reports of several subjects who indicated that they knew the answers but could not remember the names. Answers such as "The first one" seemed to indicate that transitive analysis had occurred, but that the item of analysis could only be identified by their order of input rather than by their verbal labels.

The conclusion that a single performance model operates in both presentation modes is predicated on the argument that a premise-order effect does occur in the verbal presentation mode. While Clark (1969) and Huttenlocher (1968) observed latencies reflecting premise-order effects, the present study revealed none in the verbal mode. The disparate findings can be attributed to two factors arising from methodological differences: (1) Unlike Huttenlocher's Ss, the Ss in this study were not prompted to remember each premise. Unlike Clark's Ss, the present Ss could not refer to written input. As a result, the number of Ss used in the present analyses of correct responses decreased to an average of eight, as contrasted to Huttenlocher's 48 Ss and Clark's 13 Ss; (2) Huttenlocher exposed her Ss to each problem-type four times. Clark's means (across question-type) were derived from six exposures per S. The mean latencies in the present study were derived from only two exposures per S. Therefore, the possibility is not ruled out that this effect is a real one; that is, that the role of the middle item does play a part in determining differential difficulties in linear and nonlinear premise-orders.

As noted in Results, concrete syllogisms were easier to solve than verbal syllogisms. This difference can probably be attributed to encoding differences rather than to transformation differences. In the verbal condition novel names had to be remembered each time a syllogism was presented. In the concrete condition only three color-labels had to be remembered throughout the 24 problem presentations. Atwood (1971) suggests that in some tasks, adults recode verbal input into a visual representation system (this need not involve "imagery") before encoding the information in memory. In verbal tasks the added number of encoding transformations might also contribute to an increase in error-frequency.

Children

The children employed in the study showed transitive inference on tasks in the concrete mode in which three items were simultaneously presented and compared. However, they were unable to infer series on tasks in which items were presented and compared in pairs (as premises). The contrast between performance on the separate-premise concrete and verbal problems and the continuous-premise concrete problems (the type used in the selection pre-test) can not be attributed only to the requirement that Ss synthesize a single middle term from two separately presented items. Roodin and Gruen (1970) and Bryant and Trabasso (1971) employed two middle items in their experiments in attempts to facilitate memory, and found performance increments. It is possible, then, that the increase in problem difficulty is due to the requirement of the two-premise presentation that S retain and transform terms and relations without referring to actually present input. If such retention is planned retention, then this performance decrement can be characterized as one due to a competence inadequacy. Planned retention implies that S can predict the need to retain information. In this case, in order to recognize the retention requirement, S must possess a representation of the problem format. S must characterize the format as an abstract propositional structure (that is, as two separately-presented premises from which a middle-term and two end-terms must be derived) before he can solve a particular example. There is a distinction between the ability to recognize relational properties among items already present in memory, and the ability to predict the occurrence of relational structures and to thereby plan for retention. When verbal items are presented auditorally, they are subject to rapid fading and must be reconstructed in memory before being transformed and related. Similarly, when concrete items are presented visually and withdrawn from the visual field, they must be represented in memory. Piaget and Inhelder (1971) distinguish between reconstruction of a representation and anticipation of it, characterizing the latter as a more complex cognitive act. In order to identify relevant input to be stored, S must anticipate its future use. In situations in which items associated with input can be referred to after the initial input, the need to anticipate problem format is eliminated. The formal operational level comes into play here in allowing S to predict and thereby identify relevant information to be retained, rather than in allowing S to analyze information already stored.

Though the child Ss of the present study did not respond with the criterial number of "correct" answers and were therefore judged as not having made transitive inferences, their responses were rule-guided. In the concrete mode, most Ss appeared to be employing a strategy in which only the second (accessible) premise was referred to. No series was reconstructed, but the relation in the second premise tended to determine the answer to each question asked. For example, a problem of the form "B/C; A/B, Which is tallest?" would elicit the answer "A", while an identical set of premises followed by the question "Which is shortest?" would not elicit the answer "C". In the verbal mode, single-premise strategy, generally manifested in reference to the second premise, the one most accessible in memory, characterizes a portion of Ss' performances. Also indicated was the trend to answer questions with the middle-term. This tendency is probably due to the fact that the middle-term is the only item which appears twice in input. Retention of a name which is heard two times may be facilitated. It would appear, then, that in the verbal mode individual Ss are applying at least two strategies: one in which a second premise tends to be recalled, and another in which the twice-repeated term is recalled, possibly without reference to the relation it has to any other item. The prediction that S would only refer to the second premise in answering questions received some support in analysis of the concrete mode. In the verbal mode, although a single-premise strategy does occur, a tendency to retrieve information from the second premise operates in combination with a tendency to retrieve the twice-repeated item.

The lack of an effect of congruence between the first premise and the question on retrieval of an answer in the second premise suggests that information in the first premise is replaced by information in the second premise. A memory system designed to store (or retrieve) only one relation might tend to ignore all relational input, other than the most recent. Though the children in this study were capable of simultaneously considering two relations (e.g., A > B; B > C) and were capable of storing two relations when given sufficient cues, they did not do so spontaneously. Many Ss reported that they had seen a total of four items, rather than three items with one shown twice.

As in the adult results, fewer objectively correct answers occurred in the verbal condition than in the concrete condition. In the present study, an objectively correct answer is incidentally identical to the answer of an S who refers only to a second premise as an interpretational strategy. For example, in the syllogism "B > C; A > B. Which is tallest?", A is the tallest of all three and the tallest within the second premise. Since no Ss met criterion for transitive inferences, the "correct answer" measure can be interpreted as more precisely indicating the success of a second-premise strategy. In this light, second-premise strategies were successful less often in the verbal condition than in the concrete condition. This difference can be attributed to the same factors identified in explaining the adult difference.

Latencies were not employed in analysis of child strategies. Preliminary analysis rescaled a wide variation within and between S and no trends comparable error-type distributions were indicated.

Children and Adults

In the analysis of adult strategies, a FI was postulated to influence storage and retrieval processes necessary to identify the middle-term and/or the series in both the concrete and verbal modes. In the child sample, a second-premise strategy was postulated in both modes.

The proposed performance models suggest that both verbal and visual input can be operates upon in quite similar manners. Items or relations salient to attention are preferentially retrieved and examined. Memory processes would appear to play a major role in determining the process of a strategy, since limited storage space or limited "retrievability" requires a strategy in which some terms are given priority ratings. Postman (1972) suggests that

> Recall is organized because the subject "perceives and detects" the structure of the list during input, encodes and stores a general representation of this structure, and on this basis forms a retrieval plan to guide his search through the independent item traces (p. 13).

Bruce (1971) finds that this ability to recognize and use the logical structure of a list, measured by accuracy of serial learning, qualitatively develops with age.

The children in this study may have been incapable of assigning appropriate "priority ratings" to relevant information, though they could transform it appropriately when not required to spontaneously store the information. In Piagetian terms, they did not possess an operative competence structure sophisticated enough to reconstruct a figurative series, though when task demands were reduced (i.e., the planned storage requirement was reduced) they could reconstruct the series. Adults, on the other hand, were able to "perceive or detect" the abstract structure of the information during input, and thus could recall and appropriately transform it in reaching an end-state involving transitive inference.

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AN ANALYSIS OF ORGANIZATIONAL STRUCTURE BY APPLICATION OF INDIVIDUAL DIFFERENCES MULTIDIMENSIONAL SCALING[1]

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November 1973

Prepared for the

MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH

of the

University of Georgia

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PS011512

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[1] This report was supported in part by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education, and the Department of Psychology, University of Georgia. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

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Preface

The meaning and measurement of social structure is, at least, as important as that of intellectual structures so far as evaluation of educational programs is concerned. Terms like "classroom structure," "open classroom," "individualized instruction" are commonplace, but seldom hold up under analysis and often are practically meaningless. In addition, organizational structure and functioning are highly interrelated. Especially important is the relationship of an organization's structure to patterns of communication and the decision making process.

The Mathemagenic Activities Program's organizational structure and processes are presumed to be a model for implementing the general principles of change inherent in its theoretical base. The present report is a preliminary attempt to find theoretically satisfactory measurement operations for describing our RD&A social-organizational structure. Results of the analysis of that portion of the data reported here are encouraging in that meaningful descriptions of "psychologically real" social structures, whether it be a classroom or Local Educational Authority, are possible. Future work might well concentrate on more detailed analysis of the data relevant to identification of the structural characteristics, decision making rules and communication patterns, "real" or perceived, that conflict with the theoretical model and/or place constraints on the performance of individual members of the organization.

C. D. Smock
March, 1974

An Analysis of Organizational Structure
By Application of Individual Differences
Multidimensional Scaling

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INTRODUCTION

Organizational psychology is a relatively recent outgrowth of psychology and sociology theory and research. A review (Lichtman and Hunt, 1971) located some 125 publications on the subject of organizational theory, but less than ten were written before 1950 and over 80% appeared after 1960. Katz and Kahn (1967) believe that psychologists were either "unable or unwilling to deal with the facts of social organization and social structure." Sociologists, who characteristically are students of social structure, appear to have dealt adequately only with "small face-to-face groups."

An explanation for this neglect is most plausibly attributed to deficiencies in theories of organizations held by psychologists and sociologists. Lichtman and Hunt (1971) take the position that "a theory of organization can be no better than the assumptions it makes about the human personality"; i.e., the quality of a theory of organizational behavior is influenced, if not determined, by the quality of the personality theory. Further, organizational research strategy can be only as strong as its theoretical base. Levy and Pugh (1969) state the issue quite clearly: "choice of a method of analysis necessarily implies a choice of a theory of organizational behavior."

Several personality theorists have attempted to establish conceptual models of organizational behavior and appropriate research methodology.

Herman and Hulin (1972) propose two categories into which these organizational research strategies can be divided: 1) studying individual differences within a single organizational context; and 2) studying organizational characteristics across a number of organizational settings. Inskon, Payne, and Pugh (1967) emphasize that whether the type of measurement operations is objective (the "direct" assessment of organizational properties) or subjective (assessment through the perceptions of the organization members) will necessarily shape the analysis. Likert (1961) introduced controlled field experiments and interview methods in an effort to get away from the traditional methodologies (i.e., sociograms) in research on organization. Inskon, Payne, and Pugh (1967), on the other hand, have argued for the application of psychological scaling techniques for analysis of individual behavior to what are traditionally sociological data. Some of the more recent developments in the methodology of organizational analysis involve the incorporation of multivariate techniques. Levy and Pugh (1969) and Prien and Ronan (1971) present two separate studies which implement factor analysis and multiple regressions analysis for determination of the major dimensions, or factors, of an organization. Despite parallel research strategies and techniques, there "appears to be limited concensus across all studies" (Prien and Ronan, 1971).

The organizational analysis reported here is based on the perceptions of individual members of the organization. It is assumed that an accurate (i.e., psychologically real) model of a social structure can be obtained through the investigation of the interpersonal perceptions of the individuals comprising the organization. Similarity judgments are made by all members with respect to all other members of the group. It is the nature of the required judgments that differentiates our analysis from many preceding studies. It has been the usual procedure to ask for an individual's perceptions of the organization and/or its members on certain preselected dimensions. The procedure of preselection and definition is responsible for introducing certain explicit and implicit biases into the analysis. These restrictions on the nature of the task are not necessarily inappropriate but subjects many times are required to consider dimensions which do not "fit their conceptions and attitudinal structure relevant to the organization."

The similarity judgment approach used here does not yield judgments that in themselves are sufficient, but implementation of an individual differences multidimensional scaling (MDS) procedure permits these judgments to be used to reconstruct the social structure of the organization.

The particular MDS program used in this analysis was Vitala R. Rao's (1969) revision of Douglas Carroll and Jie Jih Chang's INDSCAL. It is only one of the products resulting from an increased interest in the field of multidimensional scaling. Begun in the late 1930's by Richardson (1938), it remained relatively undeveloped until Torgerson (1952), Messick (1956), Abelson (1954) and others developed methods of metric MDS in the early 1950's. During the 1960's nonmetric MDS has received the attention of both psychologists and statisticians including Shepard (1962), Kruskal (1964), and Carroll (1970). Multidimensional scaling is an extremely flexible tool and has been found an effective tool for those interested in marketing (Green and Carmone, 1970), political science (Wish, Deutsch, and Biener, 1971), audition (McDermott, 1969), organizational analysis (Jones and Young, 1972) as well as statistics.

The model INDSCAL consists of geometric representations of the social structure as determined through the similarity judgments. There are two basic geometric representations as part of the output of the program. The first represents the patterning of the individual's unique use of dimensions and the weight to which they assign importance of each dimension; i.e., a higher weight on a dimension indicates more use of that dimension. The second geometric structure represents the average perception of the group with an assignment of each individual's position on each dimension. The distances between the individuals in the geometric space correspond to the degree of similarity between them; i.e., the greater the distance, the greater the perceived difference between the subjects.

The analysis of the geometric representation of the organization provides the basis for the analysis of the social structure. As has been already pointed out, an advantage of this particular type of analysis is its freedom from the introduction of the researcher's biases. The analytic approach should offer a more accurate measure of the psycho-social structure of the organization.

METHOD

Subjects

Twenty-two members of the Follow Through (Mathemagenic Activities Program; MAP) staff, based at the University of Georgia, served as subjects for the study. As a member of a Research-Development-Application organization, the staff is responsible for implementing principles for change based on the MAP model for early childhood education in six project sites; research and evaluation on which to base improvements in the curriculum and training materials utilized in the projects; and for the evaluation of each project's success in application of the model. Staff members, then, are concerned with diverse responsibilities and activities, ranging from secretarial-clerical to field supervision to data processing. Staff roles include project advisors, curriculum specialists, media technicians, research technicians, an evaluation coordinator, a field work coordinator, and project coordinator. Appendix A contains a more elaborate description of the various staff positions and their responsibilities.

Staff members' tenure in the organization ranged from six months to three years (the age of the organization) at the time of data collection. A preliminary questionnaire, to be described below, was administered to all thirty staff members. However, one person left the staff and graduate assistants were eliminated which left twenty-two subjects for final data analysis.

Data Collection

Initial contact with the staff was for the purpose of interviewing selected individuals of each of the various role descriptions. Content of the interviews as oriented toward each person's perceptions of Follow Through and its operation. Information gathered during these interviews was used in the development of unidimensional scales concerned with hypothesized organizational dimensions.

A preliminary questionniare (Q-I) was distributed to determine the amount of interaction between persons associated with the program. Each staff member was asked to estimate the number of interactions they had with each other individual on the staff during a normal work week. Analysis of the responses indicated that the graduate assistants (9) did not frequently interact with many members of the full-time staff. The small amount of additional information to be gained from the inclusion of these students, and the possibility of a drop in the reliability due to low rate of interaction and unfamiliarity, was considered sufficient reason to exclude them from the study.

A second questionnaire (IP) was the primary data collection instrument and consisted of twelve separate rating tasks relevant to interpersonal familiarity and similarity, and status on a variety of dimensions of personality/adjustment dimensions.

Twenty-two staff members were first asked to rate each other staff member, including himself, on degree of familiarity. The second scale, which provided the data fof the multidimensional scaling analysis, asked for each subject's judgments on the degree of similarity of all possible pairs of staff members (231 paired comparisons were made). Judgments were made on a nine point scale, with 1 meaning "very dissimilar" and 9 meaning "very similar." Stimulus pairs were presented in an optimally spaced random order (see Ross, 1934).

Scales three through twelve of the interpersonal perception questionnaire (IP) consisted of specific unidimensional scales on which the respondents were to rate each staff member, including "self." The scales were to obtain ratings on job satisfaction, competency, work orientation, style of interaction, job similarity, cognitive style, status, accessibility, and composure. The selection of these ten unidimensional scales was based on the interview data mentioned previously and the authors' hypothesized organizational dimensions.

Data Analysis

The data which were obtained from the IP questionnaire on similarity were compiled into two matrices for each subject. The similarity judgments were arranged in a 22-by-22 matrix unique to each subject. Cell x_{ij} of the matrix would be the similarity ratings of the pair of staff members i and j, in the same manner cells x_{ji} reflects the same information in this symmetric matrix. These twenty-two matrices provided the data for the multidimensional scaling analysis using a revised 1969 version of INDSCAL program (originally programmed by Jie Jih Chang). The analysis consisted of a three-way analysis (subjects-by-stimuli-by-stimuli) with non-orthogonal, ten through one dimensional solutions.

Ratings from the remaining eleven scales were combined into one twenty-two by eleven matrix for each project. The BMD02R (1970) multiple regression computer program was used in the determination of the relationship between the coordinate values of the subjects' private perceptual spaces (an expansion of matrices 1 and 2 of the INDSCAL output) and the eleven unidimensional rating scales. This relationship was of particular interest in the understanding and interpretation of the perceived organizational dimensions.

RESULTS

One aspect of the INDSCAL solution is the production of two separate matrices which explains the composition of the data. The first matrix consisted of dimensions-by-respondents with the obtained values (from 0.00 to 1.00) representing the degree to which the respondent used each of the dimensions in making his similarity judgments. The second matrix represented group stimulus space (i.e., subject-by-dimension) and yielded the coordinate values for each of the subjects as perceived by the group.

The private perceptual space of each subject for the entire organization can be obtained through an expansion of the data obtained in the above matrices. The formula for determining the private space (the jth dimension value for the kth stimulus for the ith subject) is:

$$Y_{ikj} = (X_{ij}) \cdot (w_{kj})^{\frac{1}{2}} \qquad (1)$$

where X_{ij} is the ith individual's weight on the jth dimension in the first matrix, and w_{kj} is the stimulus k's coordinate value on the jth dimension.

For determining which of the solutions (1) should be further investigated, interpretibility and goodness of fit (between solution and similarity judgments) were taken into consideration. The correlation between each solution and the raw data (similarity judgments) is presented in Table 1. The private space correlation represents how well each solution fits the entire group's perceptions; and the average subject correlation with the goodness of fit of the solution to the "average" respondent's perception of the organization. For the solution with 3 dimensions, the private space correlation and the average subject correlation were .5302 and .50701 respectively. Therefore, the 3 dimension solution was considered the most advantageous for interpretation.

Table 1

Correlation Between INDSCAL

Output and Real Data

# Dimensions included in analysis	Private Space Correlation Between Y(Data) and Y(Hat)	Average Subject Correlation
10	0.753446	0.74137
9	0.733225	0.72852
8	0.712731	0.70363
7	0.686945	0.67674
6	0.654989	0.64447
5	0.621065	0.60909
4	0.578006	0.56035
3	0.530225	0.50701
2	0.472257	0.44174
1	0.356169	0.32344

The respondents weights for each of the three dimensions represent the data that are produced in the first matrix of the INDSCAL output. Table 2 indicates that considerable variation exists between respondents in terms of the weight given to each dimension. This matrix can be a source of additional information for understanding the characteristics of the subjects who had similar dimensional weighting patterns. While this solution captures a large portion of the subjects using these three dimensions, several did not use any of these dimensions to any great degree. There were four individuals who did not seem to be fit by this model (09, 11, 16, and 19; i.e., two clerks, a curriculum specialist and a media technician).

Table 2

Respondents' Weights

For Multiple Dimensions

Respondent Code	Dimensions		
	I	II	III
01	0.16125	0.26074	0.34542
02	0.44423	0.18175	0.26360
03	0.09761	0.74042	0.18780
04	0.23711	0.24141	0.36424
05	0.58707	0.10821	0.21023
06	0.35416	0.04917	0.27723
07	0.34019	0.03866	0.13613
08	0.26139	0.07207	0.10468
09	0.19358	0.05110	0.19256
10	0.10618	0.09108	0.27568
11	0.16832	0.13993	0.15383
12	0.50029	0.05258	0.09487
13	0.28993	0.45126	0.21643
14	0.65568	0.19939	0.22582
15	0.41408	0.20375	0.18656
16	0.18155	0.17128	0.13019
17	0.07950	0.18953	0.29364
18	0.31506	0.13315	0.23133
19	0.12583	0.18784	0.16919
20	0.29909	0.23006	0.49135
21	0.25068	0.09985	0.16540
22	0.10460	0.67992	0.09585

A reordering of the data presented in Table 2 was made by ranking the respondent weights according to their coordinate values on each of the three dimensions and is presented in Table 3.

Table 3

Rank Order of Respondents'

Weights on Dimensions

(reordering of Table 2)

Role Code	Dimension I	Role Code	Dimension II	Role Code	Dimension III
○	0.65568	Δ	0.74042	▲	0.49135
▲	0.58707	Δ	0.67992	○	0.36424
Δ	0.50029	○	0.45126	▲	0.34542
●	0.44423	Δ	0.26074	□	0.29364
■	0.41408	○	0.24141	●	0.27568
●	0.35416	Δ	0.23006	●	0.27723
□	0.34019	■	0.20375	●	0.26360
□	0.31506	○	0.19939	□	0.23133
▲	0.29909	□	0.18953	○	0.22582
○	0.28993	Δ	0.18784	○	0.21643
Δ	0.26139	○	0.18175	Δ	0.21023
□	0.25068	□	0.17125	□	0.19256
○	0.23711	■	0.13993	▲	0.18780
□	0.19358	□	0.13315	■	0.18656
□	0.18155	▲	0.10821	▲	0.16919
■	0.16832	□	0.09985	□	0.16540
▲	0.16125	●	0.09108	■	0.15383
▲	0.12583	Δ	0.07207	□	0.13613
●	0.10618	Δ	0.05258	□	0.13019
▲	0.10460	□	0.05110	Δ	0.10468
Δ	0.09761	●	0.04917	Δ	0.09585
	0.07950	□	0.03866	Δ	0.09487

Role Codes:
□ Secretaries and Clerks
■ Media Technicians
Δ Research Technicians
▲ Curriculum Specialists
○ Project Advisors
● Co-ordinators

Symbolic representations of the six role categories have been paired with the appropriate coordinate value. Inspection of Table 3 yields several consistent patterns of dimension usage for each respective role of respondents. There is no consistent usage pattern for Dimension I, but individuals seem to be distributed according to "home office time" on Dimension II. Individuals whose responsibilities include training at local project sites make more use of Dimension II in similarity judgments than do other staff members. Dimension III usage can be characterized by the diversity of the activities performed by the individuals; characteristically the individuals are faced with tasks requiring a wide variety of abilities and activities.

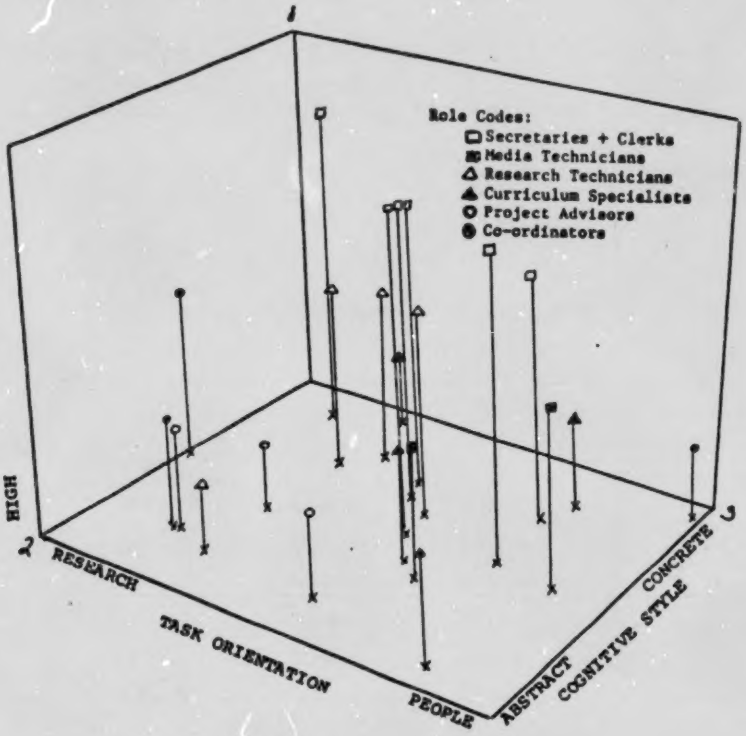
The coordinate values of the stimuli on the three dimensions are given in Table 4. Figure 1 displays the distribution of the data in three dimensional space.

Table 4

Coordinate Values for Stimuli

Stimuli Code	Dimensions		
	I	II	III
01	-0.24868	-0.34638	-0.13342
02	-0.13411	0.27227	-0.26713
03	-0.11171	0.34463	0.25841
04	-0.24988	0.14330	-0.17046
05	0.08169	-0.05906	0.04448
06	-0.22229	-0.33024	0.41805
07	0.34341	-0.01350	0.20049
08	0.06667	-0.09572	-0.14796
09	0.36657	0.00800	0.04191
10	-0.05655	0.05427	-0.41888
11	-0.08365	0.14450	0.12403
12	-0.01392	-0.17614	-0.09142
13	-0.20436	0.32061	0.00822
14	-0.17499	0.27605	-0.25232
15	0.12193	0.02150	0.30922
16	0.27478	-0.13596	-0.02276
17	0.21023	-0.18015	0.21757
18	0.30302	-0.10145	0.00134
19	-0.13999	0.11649	0.09426
20	-0.19689	-0.26936	0.23697
21	-0.32026	-0.28268	-0.25231
22	-0.24953	0.30900	-0.19826

Figure 1. Spatial representation of the perceived organizational structure.



A concentrated view of each role type and their clusters within the three dimensions is presented in Figures 2 through 8, Appendix B. In one instance (the average coordinator values for the coordinators), the estimate is distorted because of an extreme difference between one coordinator and the other two; thus, the "average coordinator" is unrepresentative of the role (see Figure 2, Appendix B).

The task of appropriately naming the dimensions of the model involved the use of a multiple regression technique. The coordinate values of the private spaces were set as dependent variables, and the multiple regression analysis stepped the ratings of the unidimensional scales in as independent variables trying to explain the dimensions. A summary of the results is presented in Table 5.

Table 5

Relationships Between Multidimensional Coordinate Values and the Unidimensional Scale Values

Dimension	Unidimensional Scale	Increase in RSQ	F-value*
1	17 - Status	.2975	204.1028
	14 - Accessibility	.0522	38.6017
2	16 - Cognitive Style	.1963	117.6926
	17 - Status	.0279	17.3141
3	11 - Task vs Person	.2166	133.2624
	8 - Research and Development vs Service Orientation	.0816	55.9623
	13 - Interaction Style	.0602	45.0219

*all F-values significant beyond the .01 level

The unidimensional scales, with three exceptions, were stepped into the regression analyses, because they satisfied the restrictions for inclusion, but only the most significant variables are presented and interpreted. Although the correlations appear high, none of the unidimensional scales (neither singularly nor in a linear combination) could fully account for any of the three dimensions. The correlations that existed between the unidimensional scales were of high strength and if one of the scales was put into the regression equation, the other scale did not add substantial additional information.

DISCUSSION

Individual Orientation

An individual's orientation toward the social-organization environment is defined by the extent to which his judgments are determined by a particular dimension of the structure of the system. Clusters of individuals on the dimensions derived from perceived similarity judgments can be interpreted as reflecting, then, a particular actualized organizational structure. There seem to be two clusters of individuals on Dimension II; those staff members involved in activities away from the main office use Dimension II more than those staff members who remain at the home office. The one research technician who is high in use of this dimension also participated in field activities.

Exceptions can be noted for the division of the staff (as noted in both the second and third dimension usage) but the overall patterning is of most interest. The distribution of respondents on usage of Dimension III represents the amount of diverse activities associated with their job responsibilities. Individuals operating under requirements for diverse conditions, or with less specifically defined tasks, seem to use this dimension more than those individuals who seem to have fairly repetitive, predictable, job activities.

The project advisors, coordinators, and the curriculum specialists use Dimension III to a relatively greater degree than the other staff. By the nature of the roles involved, they are called on to perform many diverse activities and must be able to respond appropriately when confronted with unexpected situations. One secretary also uses Dimension III in her judgments, a not unexpected finding since she is Head Secretary and performs activities not required of other secretaries. The individuals that are low on Dimension III use are in highly specialized positions; e.g., bookkeeping, typing, data processing, and computer programming.

Perceived Organizational Structure

The combination of concepts associated with each dimension represents the perceived organizational structure. The first dimension reflects a functional view of the organization in that judgments are made on the basis of the individuals' job assignments and activities, rather than on personality variables. Analysis of Dimension I indicated the two most significant variables were "status" and "accessibility" which correlated .31 with each other. The combination of these two variables yielded a distribution of the individuals with the highest perceived status and who were likely to be available at a given time. This dimension, then, reflects an ordering of persons to whom other individuals sought for help, advice, or information when wanting to speak with an available "authority" figure. However, the influence of the "accessibility" variable modifies the distribution on this dimension so that it does not entirely reflect the existing power structure, as perceived by the respondents. That is, there was not a consistent patterning of characteristics of individuals who used this dimension associated with the similarity judgments.

The second dimension is most plausibly interpreted as reflective of the cognitive complexity-simplicity style of individuals. Cognitive style affects individuals' behavior and perceptions relevant to many aspects of functioning within an organizational setting, especially the manner in which individuals confront problems and social interaction with others. Dimension II, through an examination of the distribution of the subjects along it, seems to have captured quite accurately the variation that exists within the staff members. But, it was not possible to differentiate between individuals' location on this dimension and role within the organization. Thus, it would appear that cognitive styles are not necessarily uniquely characteristic of particular roles. At the same time, the characteristics of those who are described as being Dimension II users suggest that individuals who spend work time away from the home office base similarity judgments more on cognitive style than do those staff members remaining at home (who tend to use other dimensions for such judgments).

A personality-oriented interpretation of the third dimension seems most appropriate. Specifically, the distribution of the staff members along Dimension III indicates an association with perceived work activities and interests. The dimension represents judgments based on task performance as compared to judgments more oriented toward considerations of the human or personal factors. Dimension III, thus, is interpreted as representing task-oriented versus person-oriented individuals.

Such an interpretation is further strengthened by consideration of the role types, research or service that is involved. The two major components of the formal organization -- research and development and field service -- are represented by this dimension. The distribution of the subjects is, then, an accurate reflection of the areas of assigned roles and work activities.

The major question of interest to those in administrative capacities of the Follow Through program is how well the perceived organizational structure matches the formal-idealized model. The emergence of a research-service dimension (Dimension III) in particular, and the status-accessibility variable to a lesser extent, suggests that, in fact, the organization approaches the planned model for the social-organization structure. Further, the perceived characteristics of the task orientation dimension is particularly encouraging. Successful implementation of the MAP model in the community projects depends upon an ability to offer a variety of services in the different operational components. Effective coordination and implementation of the experimental curricula and services at the project site level, as well as the supportive activities at the sponsor home base, requires a staff that is heterogeneous in attitude, talents and interests. The different weighting patterns of the social-psychological dimensions for each individual and the distribution of persons along these dimensions indicate that the formal role types and functions are fairly well realized in the psychological life space of the staff members of the MAP organization.

Appendix A

Role Descriptions

Coordinators - There are three coordinators on the Follow Through staff: the evaluation coordinator who supervises and directs all evaluative activities within the program, the field coordinator who oversees the work of the staff members operating at the various project sites, and the main program coordinator who is responsible for the direction of the entire staff in all matters of interest to the program.

Project advisors - They work with the personnel at the project sites in efforts to implement the MAP model in the classrooms and in the communities. This role requires that the individual be away from the main office one to two weeks every month. They coordinate the application of the educational curriculum, train and supervise resource personnel, teachers, and aides, and consult with the local administration on their responsibilities.

Curriculum specialists - They are mainly concerned with the creation of a curriculum reflective of the MAP model. Each curriculum specialist must be an expert in his field. This position also calls for a certain amount of traveling spent in visiting the project sites.

Media technicians - These individuals are mainly concerned with the creation of advantageous methods or medias for the presentation of the materials composing the MAP curriculum. Requirements for this position seem to emphasize creativity and expertise with media equipment.

Research technicians - This is a broad category including all individuals on the staff involved in the collection, processing and evaluation of the data on the students in the FT classrooms. Test administration, test data coding, computer analysis, and research report writing are activities divided among the four-member staff.

Secretaries and clerks - These individuals are involved mainly in operations that are of a supportive nature to the program. They take care of the tasks that must be accomplished to maintain a well-run and efficient office. Aside from the normal secretarial and clerical activities, this classification includes such activities as bookkeeping and librarian to all the program's reports and materials.

APPENDIX B

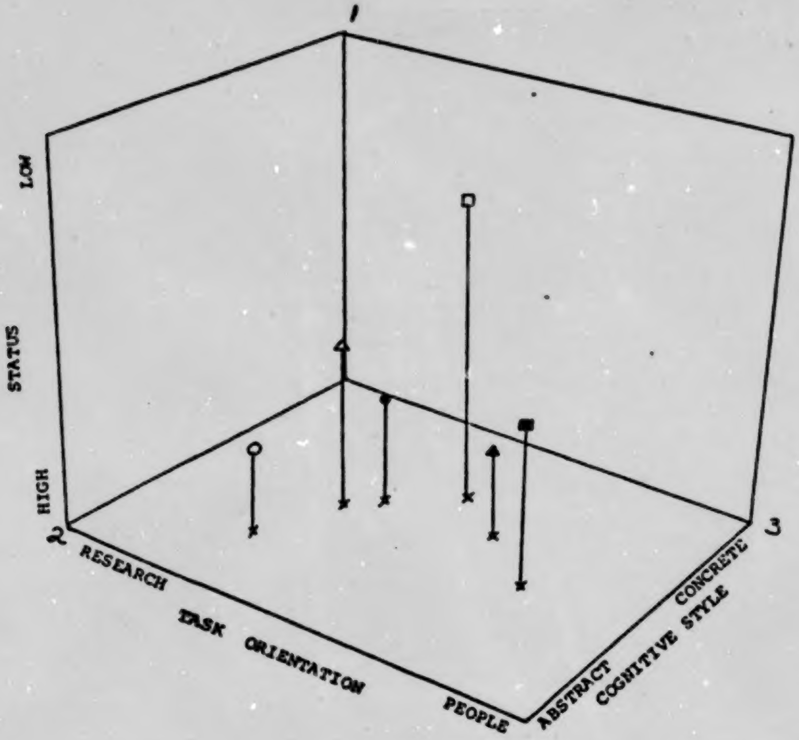
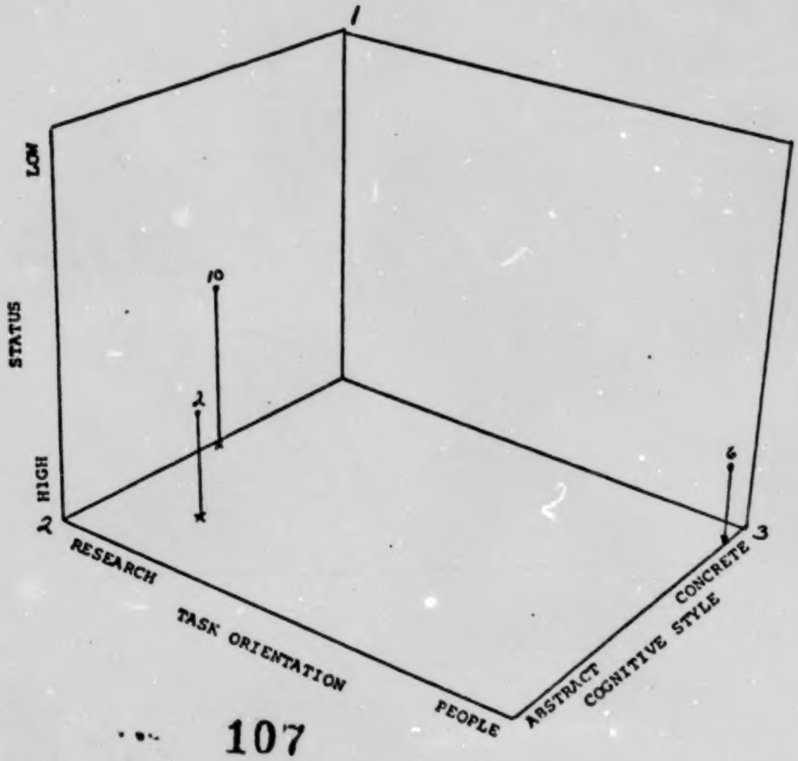


Figure 2

Average role member's location within organizational structure

Figure 3

Co-ordinators' location within the organizational structure



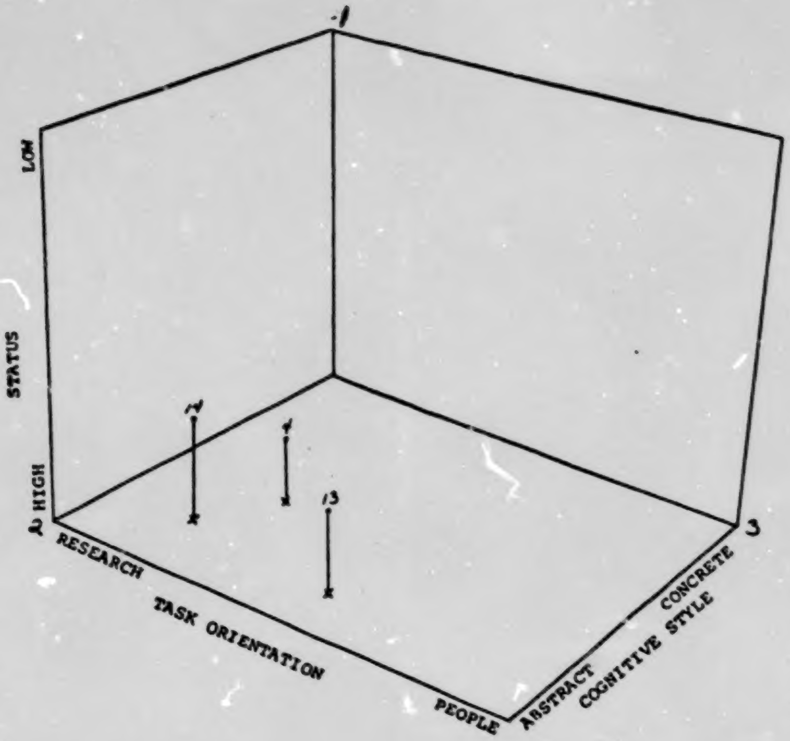
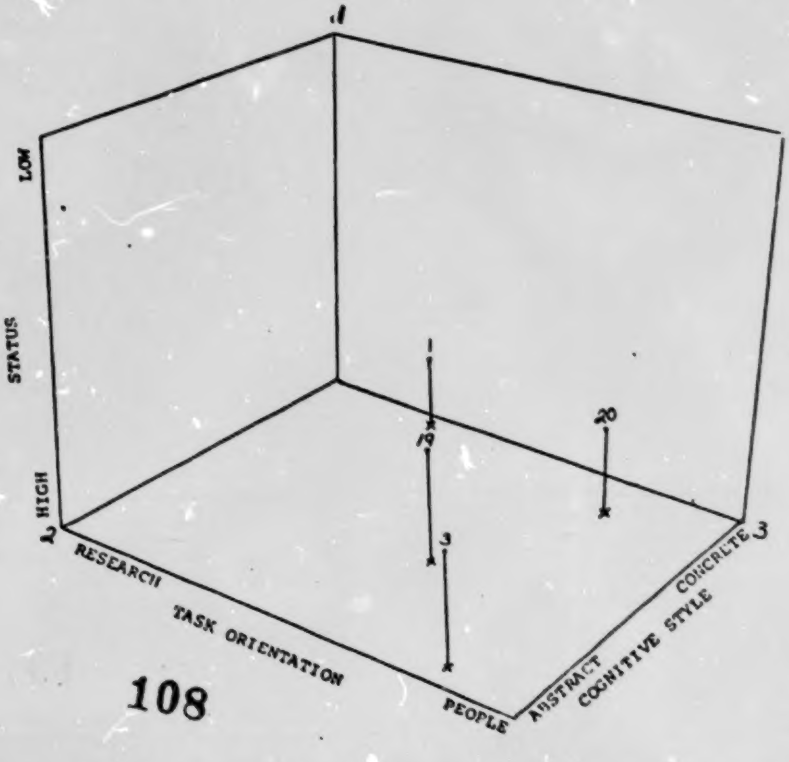


Figure 4

Project advisors' location within the organizational structur

Figure 5

Curriculum specialists' location within the organizational structure



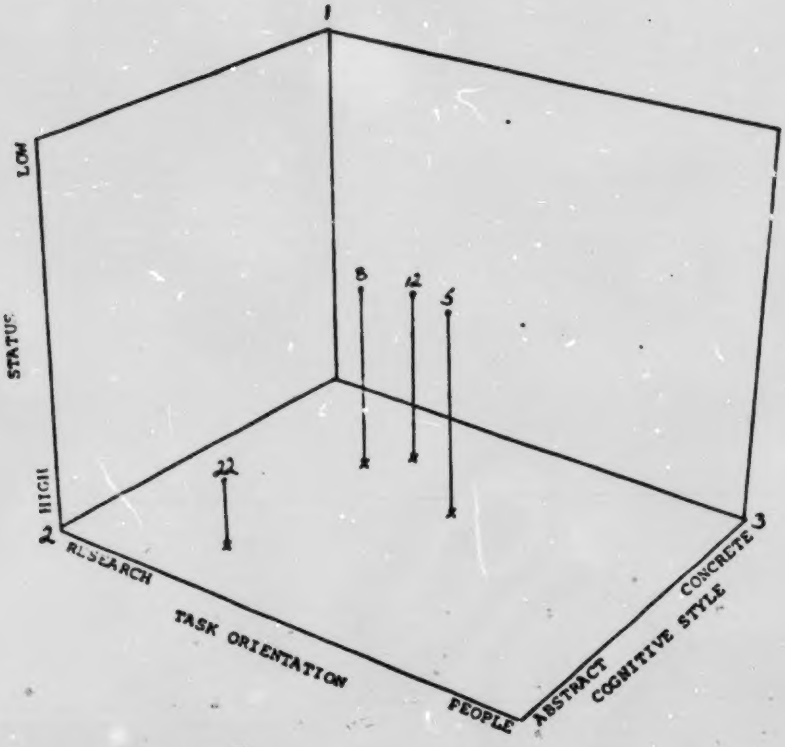


Figure 6

Research technicians' location within the organizational structure

Figure 7

Media technicians' location within the organizational structure

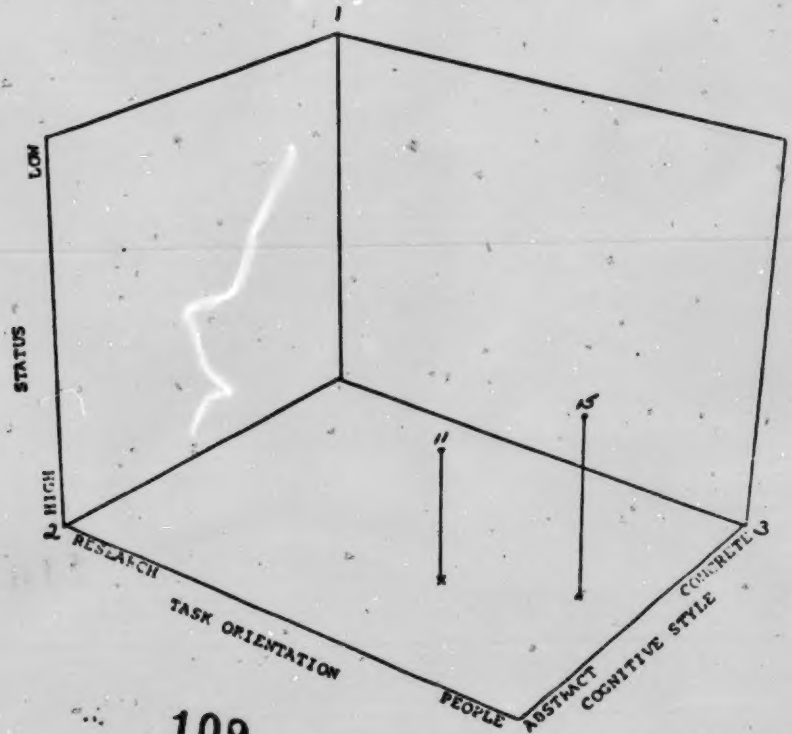
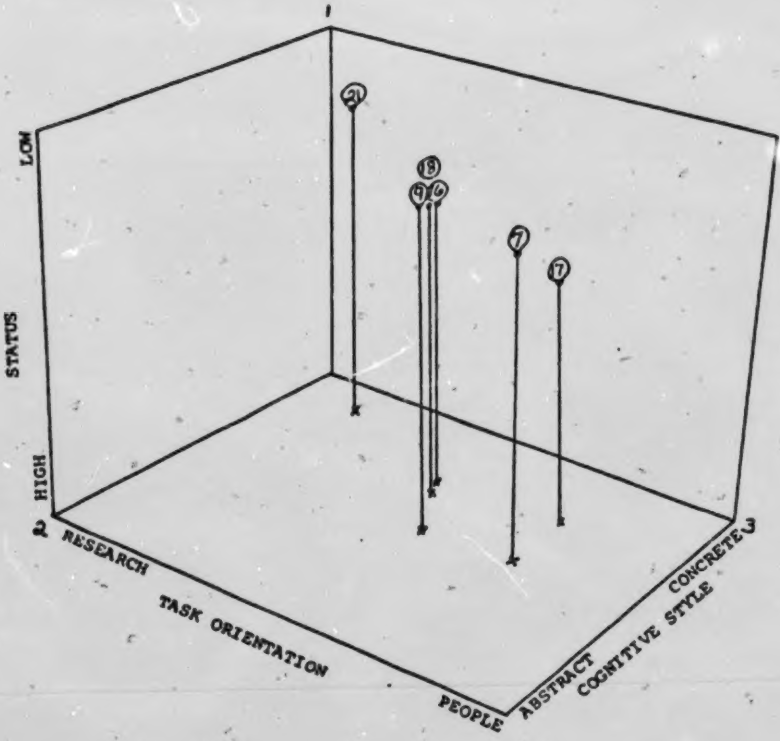


Figure 8

Secretaries' + clerks' location within the organizational structure



PS011512

A SURVEY OF COGNITIVE ABILITIES
OF CHILDREN IN DIFFERENT SCHOOL PROGRAMS[1]

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Wollongong University College/University of Georgia

Prepared for the
MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH
of the
University of Georgia
Charles D. Smock, Director

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[1] This report is based on activities supported (in part) by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

[2] This study was completed while Dr. de Lacey was post-doctoral fellow at the University of Georgia, Department of Psychology.

Preface

Evaluation of school effects is, under the best of circumstances, difficult, expensive, and, almost always, controversial. One area of controversy is the specification, and measurement, of appropriate criteria for "success" or "failure." The choice of the domain of outcomes to be evaluated is determined by many factors and not, as so often implied by some critics, the traditionalism, methodophilia and narrow-mindedness of researchers. Few would argue that either self-concept or academic achievement are unimportant outcomes of a school learning environment. Attributing "soft" heads to some and "hard" hearts to those holding different views only detracts from the study of the important and complex issues involved.

Two major issues of legitimate concern to the Follow Through evaluation program are: 1) the relation between standardized tests of intelligence (or achievement) and measures of general cognitive capabilities (e.g., problem solving); and 2) the differential patterning of cognitive abilities of children experiencing the FT-MAP classroom learning environment. This study is an initial exploration of the latter interest and, as such, contributes useful information relevant to methodological and theoretical concerns of the MAP program.

Introduction

By the mid-1960's it was clear that the cognitive gains shown by low-income American children attending short-term Head Start or similar compensatory preschools were not being maintained in the years following the preschool experience. Follow Through is one of the plans developed to explore ways to prevent the apparent "unlearning" during post-Head Start school experience.

Follow Through (FT) was structured as a research, development and application (RD&A) educational program for young children (kindergarten through the third grade) from low-income families. Twenty-two agencies and/or institutions of higher education which had developed "models" for early childhood education were asked to serve as Sponsors (i.e., "change agents") to the communities involved. Forty such community projects were authorized in 1967 under Title II of the Economic Opportunity Act and the program was expanded to include 150 projects by 1971-72. Follow Through, then, is organized as a partnership with the community educational system (LEA), the Sponsor, and the Federal Follow Through Office each participating in the decision-making and implementation of the program. The professional partners (i.e., Sponsors) represent a variety of educational approaches and provide "planned variation" that is being described, documented and evaluated by both the National Follow Through Office and Sponsor.[3]

The community Follow Through Project must be comprehensive in scope and plan to meet the needs of children for optimum development and learning

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[3] See Report to Educational Staff Seminar, Ford Foundation, February, 1974.

(Federal Regulations, 1974). The necessary components include instruction, medical and dental health, nutrition, psychological services, social services, staff development and career advancement. The specific objectives of Follow Through are:

1. To promote school learning in children from low-income families.

2. To promote development of the "whole" child by providing for adequate medical, dental, nutritional, psychological and social services often not available to children from low-income families.

3. To involve the parents in their child's education, through parent participation in the education system[4] and the classroom learning experience.

4. To promote career development opportunities for low-income parents and staff development for the teachers.

University of Georgia Model

The University of Georgia Follow Through model, the Mathemagenic Activities Program (MAP), was developed by Professor C. D. Smock (Department of Psychology), and has been adopted by communities in Georgia, South Carolina, Mississippi, Virginia, Ohio and Idaho. Mathemagenic means "give birth" (genic) to learning (mathma); thus, mathemagenic activities refer to those coordinated practical and mental (thinking) actions requiring stimulation in order to provide the individual with opportunities to construct a coherent interpretation of his physical and social environments. Concrete, manipulative materials are utilized as a means for providing the conditions that evoke and expand sensory-perceptual, memory and thinking processes characteristic and/or appropriate for children at each stage of development.

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[4] A Policy Advisory Committee (PAC) is required of each project and must be composed of 50% low-income parents with the other representatives from community agencies concerned with the welfare of children. In addition, a parent participation and involvement component emphasizes a variety of ways in which the continuity of school and home learning environments can be increased.

The classroom structure of MAP requires two instructional aides, in addition to the teacher, to provide a high level of social interaction in the small group instructional task situations. The instructional strategy involves both teacher-selected and pupil-selected (independent) learning activities. The physical and social structure of the MAP classroom encourages the simultaneous operation of several small groups in a variety of learning activities. All classrooms are carpeted (to reduce noise level) and have been provided with all additional materials and equipment necessary to provide a great variety of appropriate learning activities.

The MAP organization provides preservice and in-service workshops for training resource teachers, teachers and aides in the implementation of the classroom program. In addition, there is an on-going in-service program for all personnel, including those in administrative and/or support services.

The major curriculum emphasis in MAP is on the teaching strategies (i.e., process approach) but specific texts and activities, for grades K through 3, have been developed and/or recommended for language arts, mathematics, science, social studies, art, music, physical education, and health.

The MAP Sponsor considers the participation in planning with each community, each year, in writing of project continuation proposals of primary importance. This process includes an assessment of community and educational resources; consideration of qualifications of staff; an analysis of curriculum materials, equipment and supplies; determination of procedures for evaluation of the program impact on children, teachers, parents and other representatives of the total community (Agency representatives, LEA members, PAC members, etc.); and expected in-service plans of both MAP (the Sponsor) and community project leaders (e.g., resource teachers' plans for teacher training activities). The planning also involves the development, in cooperation with the community, of a decision-making strategy that stresses input from relevant "stakeholders" (e.g., PAC, parents, teachers, principals) within the local educational system. Special emphasis is placed by MAP on the development of local leadership for all components of the project. The training proceeds sequentially with local leaders assuming more of the major responsibilities of the program implementation each year. Gradual replacement of the MAP Sponsor staff with local staff is expected over a period of 3-5 years.

Evaluation of Follow Through

Most Follow Through programs are oriented toward improving school achievement and, thus, tests of academic achievement figures prominently in most of the evaluation efforts. However, since the Federal Office, each Sponsor and each project are all conducting some form of evaluation, a variety of measures of impact of the FT program will be available at the end of the research effort. The MAP-FT program, for example, has collected data on both academic achievement (e.g., SAT) and measures of general cognitive competencies relevant to problem-solving skills. The study of Follow Through and non-Follow Through children in the MAP program reported in this paper is an example of the latter type of evaluation.

A major purpose of the present study was to extend a series of studies being carried out in Australia with Aboriginal and white children from different environments and who have experienced different schooling programs. Most of the tests included in the test battery constructed for the present study were used in the former investigation (see de Lacey, 1972).

Rationale

The expectation of "compensatory" educational programs, such as Follow Through, is that children experiencing the programs will make more rapid developmental progress than would have occurred without such a program. While social and physical development are not neglected, the focus of most compensatory programs is upon cognitive development. Many people believe that with greater opportunity for cognitive development, fuller realization of personal potential for disadvantaged children should make more probable that the cycle of developmental and economic poverty might be broken. The comprehensive nature of the Follow Through program goes a step further -- social and health status of children must be sufficient for them to benefit from the more stimulating learning environment of innovative programs.

The ramifications of the *comprehensive* compensatory intervention program of Follow Through, however, make the task of evaluation especially complex and difficult. Not only may influences from the program reach into every aspect of a child's life, but the modifications which he undergoes are likely, in turn, to generate and/or facilitate changes in siblings, parents and others within his lifespace. Focus on the single domain of cognitive development does not necessarily reduce the task to a manageable level. For example, the standardized achievement tests forms are certainly a crucial part of evaluating cognitive change, but there are many other areas of intellectual development that must be examined if a fair picture of program impact is to emerge. Especially important is an evaluation of the contribution of the intervention program to the child's problem-solving orientation and capabilities. The present study is intended to make a small contribution to the body of evidence on the effect of MAP-FT on the development of these general cognitive competencies.

Method

Data were collected between November 1972 and February 1973 in Pickens County, Georgia; McCormick County, South Carolina; and Gulfport, Mississippi. The children were randomly selected from MAP classrooms so as to obtain equal numbers of 6-, 8-, and 10-year-old children. A total of 538 children, about equal numbers of boys and girls, low-income and non-low-income, black and white, participated in the study.

Table 1 presents the distribution of children with respect to type of educational program, income level and other background.

Table 1

Distribution of Children by Program, Race and Income Level

	Black				White			
	Low		Non-Low		Low		Non-Low	
	N	%	N	%	N	%	N	%
FT	117	88.6	15	13.4	81	58.3	58	41.7
NFT	73	62.9	43	37.1	19	12.6	132	87.4
Total	190	76.6	58	23.4	90	32.1	180	67.9

Experimental Measures

In assembling the test battery, tests or subtests were selected which would fulfill the purposes of the study, yield the maximum amount of information, be suitable for the age and ability ranges of the children under study, and could be administered in a short time.

In line with the purposes of the study, the battery included tests in three areas: general intelligence, operational thinking and language skills.

There are two tests of general intelligence - one verbal (Peabody Picture Vocabulary) and one non-verbal (Raven's Coloured Progressive Matrices) test. The tests of operational thinking were two classificatory tests (Inhelder and Piaget Matrices and Nixon Test) based on the work of Piaget. The measure of language skills was derived from three subtests of the Illinois Test of Psycholinguistic Abilities. Each of these measures is described in more detail below.

The Peabody Picture Vocabulary Test (PPVT, Dunn 1965) was chosen as the test of intelligence. Although the PPVT test has been criticized as an intelligence test (Teasdale, 1969), the limitation of primarily language relevence was more than compensated for by its advantages for this population. Basically a test of auditory vocabulary, it yields an "IQ" as a scaled score. In each item, the subject is required to respond by pointing to one of four pictures presented to him as the examiner pronounces the cue word for that item. The nature of the response requirements renders reluctance, inability to respond verbally, or misunderstanding by the examiner irrelevant to the quality of the response. This quality is an important advantage since difficulty with verbal communication is a common characteristic of the isolated, low-income children used in this study.

The PPVT includes a wide range of difficulty level in its 150 items, from naming simply objects (e.g., table, car) near the beginning of the test to identifying attributes of quite sophisticated concepts (e.g., incertitude, pensile) near the end of the test. A subject does not have to respond to all 150 items, but proceeds from a base point indicated by his chronological age, and the fact that he can answer eight consecutive items correctly, whichever is the lower, to a ceiling defined by the point at which he has failed 6 out of any 8 consecutive items. In the present study, the test was administered individually in accordance with usual practice, though it can be given as a group test for older subjects. The PPVT is published in two forms: Form A and Form B. In this study Form B was selected arbitrarily. The test has been shown to give results which are reliable (Dunn, 1965; de Lacey, Taylor and Nurcombe, 1972) and in fairly good agreement with several other tests of verbal intelligence (Dunn, 1965). It is quick to administer and can usually be given with 10 or 15 minutes.

The Coloured Progressive Matrices (RPM: Raven, 1956) was selected as the non-verbal test of intelligence. The test has been used in conjunction with a vocabulary test to assess both capacity for intellectual activity irrespective of acquired knowledge (problem-solving) as well as the fund of previously acquired information. In a recent study, Carlson (1971) has found indications that success on this test may be related to levels of thinking according to Piaget's theory of mental development. He reports that pre-operational children are able to solve Set A and Set Ab figuratively, while concrete-operational stage thinking may be necessary to solve Set B.

The test is a series of 36 multiple-choice items, each with six options. The item stem is a rectangular "flag" in which a pattern for the whole rectangle is defined, but from which one part is missing, near the lower, right-hand corner. In each item the task is to select from the six options that one which fits and completes the total pattern. The RPM is available both in the Board and the Book Form with the latter being used in the present study (Sets Ab and B).

The Illinois Test of Psycholinguistic Abilities (ITPA: Kirk and Kirk, 1965) was chosen because its successful use has been well documented for identifying specific language and conceptual defects. Three subtests were selected from the ITPA which have shown the greatest sensitivity to differences in children's environments and to the effects of compensatory education (Nurcombe, Moffit and de Lacey, 1972); Auditory Association, Verbal Expression, and Grammatic Closure. The Auditory Association subtest consists of 42 items which tap ability to deduce or complete verbal opposites and analogies in a variety of examples. The Grammatic Closure subtest measures ability to apply grammatical rules in expressing meanings using verbal transformations such as verb tenses, plurals and possessive pronouns. The Verbal Expression subtest taps ability to perceive and describe characteristics of four common, simple objects. Unlike the other subtests, the Verbal Expression measure incorporates an essential element of divergent thinking measures (Getzels and Jackson, 1962); i.e., there is no single set of correct answers, nor any limit to the number of creditable answers a subject may give.

The Inhelder and Piaget Matrices Test (IPM) was designed to test the children's understanding of multiplicative classification; that is, ability to construct intersections of classes. The matrix task is largely based on Inhelder and Piaget (1964, pp. 160-161) and consists of a series of multiple-choice items with each item stem consisting of three or five elements with a space to be filled by one of a number of options displayed.

The first of nine items was used as a trial item to ensure that subjects understood the task. In the illustrations of these items, Inhelder and Piaget (1964) refer to them by the Arabic numerals 1 to 9, but in the text (p. 159) and in the results tables (pp. 162-163) the designation is for a "practice item" (Item 1 in our Figure 6 - no results were recorded for it) and form items I to VIII (Roman numberals). This inconsistency is retained here to facilitate comparisons of our results with those of Inhelder and Piaget.

Some minor changes in content were made, where it was considered that certain elements in the items did not represent objects which were encountered approximately as frequently by all the children tested. Item 1 (the practice item), 2, 3, 5, 6, and 7 were retained exactly as in the original items. In Item 4, lemons (or limes) were substituted for pears. In Item 8 a correction was made. Among their eight multiple-choice options, Inhelder and Piaget (1964, p. 161) show two white dogs facing left and two others facing right; i.e., they have two pairs of identical options. As the answer required is a spotted dog facing left, and as there is no such dog among the options, one dog of each pair of white dogs was provided with spots.

The elements of the original Item 9 were tulips and anemones, differing in size and colour. No flowers were found which could be substituted and recognized by all four populations, so hands and feet, also differing in size and colour, were used instead.

The modifications made to this test are essentially the same as the modifications carried out by de Lacey (1970).

Inhelder and Piaget did not say clearly what colours were represented by the three kinds of shading in their black-and-white pictures of the items, although it is possible to infer two of the colours from the recorded dialogue between experimenter and subject (Inhelder and Piaget, p. 164). It is assumed here that the choice of colours for the various elements is unimportant, provided of course that they are clearly distinguishable, and that possible confusion of red and green, or yellow and blue, by protanopic, deuteranopic or tritanopic colour-disabled subjects is precluded by avoiding the use of the colours of any of these pairs together in the same item. The missing information has been supplied by improvisation.

The practice item and the first four test items (2 to 5) were 2-attribute items (colour x shape in 2 and 3, shape x number in 4 and colour x orientation in 5), and the last four were 3-attribute items (colour x shape x orientation in 6, 7 and 8, and colour x shape x size in 9). This plan also followed that of Inhelder and Piaget.

The same administration procedures used by Inhelder and Piaget (1964, pp. 159-163) were followed. Each item stem was displayed and its options were indicated in succession. Every child was allowed to try each of the options in the empty cell until he decided on the one that fitted best. The order of presentation of the items was constant. Each child was asked (1) to find the correct option, (2) to justify his choice, (3) to say whether any of the other options might fit as well or better (this question to test stability of choice).

The scoring system was based on the procedure used by Inhelder and Piaget (1964, pp. 162-163). Records (for each subject) were kept of correct responses as well as identification of all the criteria (either two or three) necessary for the correct response. If an item was incorrectly completed, the incorrect option was recorded. This scoring procedure permits the identification of both graphic[5] and operational solutions. Operational items were considered to be those which were stable, in which the correct option was chosen, and for which all criteria were nominated. Graphic solutions were considered to be those where the correct option was chosen, but in which all the defining attributes could not be identified.

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[5] Lunzer and Papert, in translating La genèse des structures logiques elementaires under the English title The early growth of logic in the child, adopted the term "graphic" as a translation of the original "figuratif." Flavel (1963), on the other hand, translated this term as "figural."

The Nixon Test of Reclassification measures the children's ability to switch from classifying certain elements according to one criterion (e.g., shape) to classifying the same elements according to another criterion (e.g., colour). Ability to reclassify has been described by Inhelder and Piaget as characteristics of the child who shows flexibility in foresight as he anticipates a classification before carrying it out and as a mark of operational thinking (Inhelder and Piaget; 1964, p. 196). Two kinds of experiments are used to demonstrate this flexibility of thinking: first, a reclassification caused by the addition of new elements (Ibid., pp. 197-198), and, secondly, a reclassification of existing elements (Ibid., pp. 208-209). We concentrated on the second kind of experiment, because it is simpler to administer. Yet it is still relatively complex, as is seen in the following description:

> The subject is first shown the main group of objects comprising squares and circles, red and blue, in two sizes: 25 mm. and 50 mm. (side or diameter respectively). He is first asked for a verbal description of these objects. Then he is told to classify them as he sees fit. Next, he is required to make a dichotomy using two large boxes. ... We go on to ask for alternative classifications up to a maximum of three. Finally, for certain subjects, we went on to introduce shapes measuring 13 mm. or 75 mm. ... (Inhelder and Piaget, 1964, p. 208)

For the present purposes, this procedure was considered to be too complicated, and to require too verbal a response. But Nixon (1966, 1968) has developed a simpler reclassification test, tapping the same kind of skills. Nixon described her test as a "cross-classification" test; but it is not really so in the view of Inhelder and Piaget, who define cross classification as a "matter of classifying objects in terms of two simultaneous criteria" (Inhelder and Piaget, 1964, p. 1975 - the italics are ours). Nixon's test, on the other hand, requires subjects to classify elements according to three criteria but successively.

The materials of Nixon's test consist of 20 small wooden rods which differ in three attributes: height, diameter and colour. The task required of the subject can, in our view, be explained to him much more easily than in the reclassification test of Inhelder and Piaget. In turn, the subject can show that he understands the reason for a successful solution (as in the operational solutions to the I & P Matrices) simply by uttering one word: a colour name when the criterion is colour, "fat" or "skinny" when the criterion is diameter, and "tall" or "short" (or equivalent expression) when the criterion is height.

No alteration was made in the content, administration or scoring of the test, which Nixon has described as follows:

> The test chosen presents two mutually exclusive classes to the child and requires him to use the same elements to make two different classes. Items were constructed from a set of 20 rods, the attributes of which are set out in the matrix below:

	Blue	White	Green	Red	Yellow
Tall thick	1	2	3	4	5
Short thick	6	7	8	9	10
Tall thin	11	12	13	14	15
Short thin	16	17	18	19	20

> (Each rod was numbered on its base)
>
> Two groups of rods, differing in a single attribute, were placed in front of the child and he was told to make two different groups, the experimenter defining the required groups by giving as clues two rods which differed on a single, different attribute. When the child has completed his grouping, he was asked to state the attribute which differentiated one group of rods from the other. Thus two scores were obtained for each child: R only, the number of items on which the child correctly grouped the rods; and R + E, the number of items on which he combined a correct grouping of the rods with an acceptable explanation of his group. (Nixon, n.d., pp. 2-3)[6]

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[6] A similarity is apparent between Nixon's R and R + E scores on the one hand, and the graphic and operational solutions to additive or multiplicative classifying of Inhelder and Piaget (1964).

Describing the task, Nixon continues:

> It consisted of six items, built up on the following plan:
>
> | | | |
> |---|---|---|
> | 1. | Dichotomy based on colour | Dichotomy based on height |
> | 2. | Dichotomy based on height | Dichotomy based on colour |
> | 3. | Dichotomy based on colour | Dichotomy based on diameter |
> | 4. | Dichotomy based on diameter | Dichotomy based on colour |
> | 5. | Dichotomy based on height | Dichotomy based on diameter |
> | 6. | Dichotomy based on diameter | Dichotomy based on height |
>
> Each class consisted of four rods, and each item used rods of two colours. The experimenter defined the two new classes in front of the subject, well apart, and saying, "Put with that one all the ones that are like it," repeated for each exemplar . . . Before the items were administered, a standardized introduction to the rods was given to make each child familiar with their colour, height and diameter, and to ensure that the children could use appropriate words to describe the rods. This introduction included a practice item.

Two attempts at each item were permitted by Nixon if the first was unsuccessful, following the precedent of Inhelder and Piaget. Children in the present study appeared to attack any repetition as though it were a new item.

Results

A problem in this study, which is shared with most evaluations of Follow Through, was the difficulty of maintaining an adequate experimental design. Children in Follow-Through classrooms were generally, by definition, children from the lowest income families. Non-Follow Through samples included some higher-income children and would be expected to score significantly higher in most measures involving cognitive abilities.[7] Thus, any finding of no difference between performances of Follow Through (FT) and

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[7] See U. S. DHEW Publications No. (HSM) 72-1011 and (HSM) 72-1012.

Non-Follow Through (NFT) samples could plausibly be interpreted as a "positive" finding in terms of a favorable impact of the program on Follow Through children.

As Table 2 indicates, the FT program has not arrested the decline in performance between ages 6 and 10 of the labelling and inferential abilities presumably tapped by the PPVT. The performance of the NFT sample, as expected, remained relatively stable on the Peabody test.

Table 2

Peabody Picture Vocabulary Scores (Scaled)
for Follow Through and Non-Follow Through Children
at Ages 6, 8, and 10 Years

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	88	87.43[1]	17.24	91	90.89[1]	16.39
8	94	88.72	14.74	87	93.29	16.73
10	83	83.60[2]	17.59	76	90.72[2]	17.76

[1] $t = 1.37, p > .05$

[2] $t = 2.53, .05 > p > .01$

On the Raven's Progressive Matrices, however, the FT children were lower at age 6, but were at the level of the NFT children by ages 8 and 10 (see Table 3).

Table 3

Raven's Progressive Matrices Scores for Follow Through and Non-Follow Through Children at Ages 6, 8, and 10 Years

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	88	13.44	4.25	91	15.06	3.78
8	93	18.94	6.16	87	19.81	6.05
10	83	24.30	6.49	78	24.86	6.19

The Inhelder and Piaget Matrices include tasks similar to those of the RPM, except that the I & P Matrices require the child to provide the criteria by which he achieves the solution. Table 4 indicates similarity in performance for the FT and NFT groups at ages 8 and 10 on the I & P Matrices.

Table 4

Inhelder and Piaget Matrices Scores for Follow Through and Non-Follow Through Children at 8 and 10 Years of Age

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
8	93	3.47	2.26	86	3.77	2.62
10	82	4.94	2.42	81	4.99	2.10

The Nixon Task results indicate slightly superior performance for FT and NFT children (Table 5).

Table 5

Nixon Tasks Scores
for Follow Through and Non-Follow Through Children
at Ages 6, 8, and 10 Years

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	88	3.12	1.59	91	2.60	1.58
8	92	4.23	1.48	88	4.52	1.55
10	20	5.40	0.94	23	4.91	1.38

Among the ITPA subtests, a similar, but moderate, loss in scaled scores was obtained by both the FT and NFT groups (Table 6).

Table 6

ITPA Subtest Scores
for Follow Through and Non-Follow Through Children
at Ages 6, 8, and 10 Years

ITPA Auditory Association Scaled Scores

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	86	31.80	8.51	91	30.63	9.65
8	94	29.30	9.13	80	32.30	9.41
10	82	28.37	9.02	75	28.41	11.84

ITPA Verbal Expression Scaled Scores

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	88	32.04	4.37	91	31.15	4.20
8	93	27.18	4.02	87	27.24	3.72
10	83	25.69	3.04	76	26.04	3.61

ITPA Grammatic Closure Scaled Scores

	FT			NFT		
Age	N	Mean	SD	N	Mean	SD
6	82	33.83	8.50	90	34.92	7.75
8	94	29.76	8.75	87	33.04	8.21
10	83	26.61	11.38	76	29.99	10.30

A comparison between the above U. S. and our Australian data is given for the I&PM in Table 7 and the Nixon Test in Table 8. Both tables show that, for a disadvantaged group, the FT are performing relatively well on these areas of cognitive functioning.

Table 7

I&PM Mean Scores for Australian and U. S. Children
at Ages 8 and 10

	US		AUST		
Age	FT	NFT	HA[1]	LE[2]	HE[3]
8	3.47	3.77	0.30	1.56	2.76
10	4.94	4.99	2.58	2.64	4.56

[1] High-contact Aboriginals

[2] Low-income Europeans

[3] High-income Europeans

Table 8

Australian and U. S. Mean Nixon Scores
at Ages 6, 8, and 10 Years

	US		AUST		
Age	FT	NFT	HA[1]	LE[2]	HE[3]
6	3.12	2.60	1.20	2.10	4.68
8	4.23	4.52	3.00	4.32	4.98
10	5.40	4.91	4.68	4.62	5.70

[1] High-contact Aboriginals

[2] Low-income Europeans

[3] High-income Europeans

In summary, this survey has shown that the MAP model of Follow Through appears to have prevented the expected cumulative performance deficit for the low-income (FT) children in the non-verbal areas measured. There reamins, however, an accumulating deficit on some of the verbal performance tasks. Further, and more detailed, analysis of these data should clarify the interpretive significance of the variation in impact of the FT-MAP program on the different cognitive abilities assessed in this study.

DISCUSSION

It has already been pointed out that an important limitation on attempts to evaluate Follow Through programs is the lack of matched comparison groups. Such comparison groups as are customarily used are generally of higher average income families, and are likely to score higher on most tests than the low-income Follow Through children. Further, entry ability level and fidelity of implementation of the MAP program are not considered in this report. And, data other than scores on tests of school achievement and/or cognitive development need to be considered in evaluating programs like Follow Through. These points must be kept in mind in thinking about the results presented here. It would be as premature to judge the "success" or "failure" of Follow Through only on the basis of such measures (as has been the case for some evaluations of Head Start). While this initial analysis of data does not yield strong evidence of "success," more refined analysis (e.g., taking entry ability in account) may well indicate that MAP-FT does markedly increase the relative achievement, and cognitive competencies, of Follow Through children (Silverman, Ebert, Favata and Smock, 1974; Mosheni and Smock, 1973; Smock and Ebert, 1973).

In the light of these considerations, the Follow Through children in the MAP program have performed relatively well on most tests in this battery. The best performances were recorded on the tests of operational thinking (the Nixon and Matrices tests) where the scores compare favorably with Non-Follow Through children, and with the high-income children in Australia. The Follow Through children also scored well on the Auditory Association subject of the ITPA, though less well on the Verbal Expression subtest. The general trend, averaged over the three communities, for performance on the Raven's Progressive Matrices was that the Follow Through children were slightly below their Non-Follow Through counterparts at age 6, but were equal to them by age 10.

It was in the area of formal language skills that the Follow Through children did most poorly. Scores on the Peabody Picture Vocabulary Test and the Grammatic Closure subject of the ITPA were substantially lower for the Follow Through than for the Non-Follow Through children. The greater difference between the two 10-year-old samples suggested that the cumulative deficit in formal language development, as measured by the ITPA, has not been arrested by the MAP program.

In order to obtain more meaningful interpretation of the program effects, however, it will be necessary to:

1. Locate a comparison group of low-income Non-Follow Through children consisting of equal numbers of black and white subjects at ages 6, 8 and 10 in a rural environment.

2. Collect normative data on the I and P Matrices and the Nixon tests on children from managerial-professional families at the ages 6, 8 and 10.

3. Conduct follow-up studies, with the same test battery, over the next two years with the 11 and 12 year old children to determine whether there are any subsequent erosion of gains reported here.

4. Direct more research attention to the problem of determining whether the MAP program or measurement procedures are responsible for the relatively poor language performance of the MAP-FT children in the study.

In her appraisal of Follow Through, Stallings (1973) argues that Follow Through has succeeded by providing the children a wider variety of activities, more individual attention, and more constructional materials. Follow Through children also receive more praise for accomplishments, more verbal initiative, more often solve their own problems, respond more to teacher questions and requests, and are more independent. Non-Follow Through children, by contrast, are more often taught in large groups, more often teach each other and are more often punished.

It cannot be that any specified "failure" of Follow Through is the reason why the program is being phased out over the next few years. Rather, Follow Through was conceived as an experiment in planned variation of educational programs; its termination is part of that R & D plan. As an experiment, it merits the serious attention of those who are interested in innovation and research in compensatory education whether at the federal policy or the classroom level.

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LIFEWAYS AND COGNITIVE PERFORMANCE IN AUSTRALIA AND THE UNITED STATES[1, 2]

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PS 011512

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[1] This report was supported in part by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-8-522478-4617 (287) Department of HEW, U. S. Office of Education, and the Department of Psychology, University of Georgia. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be referred.

[2] A paper based on this report was presented to the Annual Conference of the Australian Institute of Aboriginal Studies (May, 1974).

Preface

Ecology is now an "in." The response of educators has been more rapid than usual; new curricula for introducing young children to "environmental studies" are already available. We hope, however, that broader and, perhaps, more fundamental implications of ecological analysis will not escape appropriate attention. First, the present emphasis on parent participation and involvement in the school will dissipate unless an adequate conceptual and empirical basis for that process is developed. Psychological and social ecological studies are necessary prerequisites both for understanding the source of many current conflicts between the school and community systems, and the generation of program processes that continually renew the parternership of school and home around their mutual concerns for development of children.

Second, evaluation of school effects can no longer ignore the fact that the extra-school learning environemnts (e.g., home and neighborhood) currently seem to determine, in large measure, learning "capabilities" (including motivation). I use "currently" because modification of the school learning environment in directions indicated by ecological studies should increase the contribution of the school to the child's ultimate level of capability and "success in life."

The study reported here indicates that appropriate research methodology is in its "infancy" but that consideration of the most general learning environment (i.e., "culture") has components related to specific intellectual abilities. For these reasons, we hope more researchers concerned with educational and child development will become interested in the many promising leads suggested by the "ecological functionalism hypothesis."

Lifeways and Cognitive Performance in Australia and the United States

P. R. de Lacey and C. D. Smock

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Over several decades of the present century, psychologists from western cultures have designed and administered tests to individuals in a large variety of cultures. Nearly always it has been found that non-western subjects perform at a lower level than western subjects. On the basis of these findings, psychologists such as Porteus (1965) and Noble (1973) have recently proposed a probable hierarchy of abilities associated with the membership in ethnic groups.

An alternative approach to explaining differences among ethnic or cultural groups in test performance has been suggested by Berry (1966, 1971). He proposes an ecological functionalism hypothesis which implies that the demands of the ecology bearing upon a society, together with cultural aids, by means of which the members of the society adapt to their ecology, leads to the development of particular perceptual and cognitive skills. Support for Berry's hypotheses emerged from an elaborate study of city white and remote urban Aboriginal children by Dasen (1974). Indeed, the degree of support for the ecological functionalism hypothesis has prompted Berry and Dasen to suggest (1974; p. 426) that prediction of differences in patterns of abilities could be made on the basis of a prior analysis of relevant cultural variables. The purpose of this study was to determine the tenability of the ecological functionalism hypotheses. Specifically, two types of cognitive tests were administered to 13 samples of 348 children from populations which varied on four environmental variables. The association between each set of test scores and the environmental variable was then determined.

Subcultural Samples

The thirteen samples of children lived at four locations in Australia and two in the United States. The Australian samples included Aboriginal children at Aurukun and Alice Springs, and white children at Alice Springs and at two Sydney suburbs, Granville and Pymble. Aurukun is a mission station on the remote north-western coast of Cape York Peninsula, in northern Queensland. About 600 Aboriginal and a dozen or so white individuals and families live at the mission, which is accessible only by occasional steamer or light aircraft services. A fuller description of the Aurukun community is available elsewhere (de Lacey, 1970). Alice Springs, in the center of Australia, has a population of about 9,000, a minority of whom are Aboriginals who live in small cottages or in a dry river bed which runs through the town. The white sample from Alice Springs attended the same school as the Aboriginals and were from census categories 0 and 01; i.e., unskilled or semi-skilled labourers. The children from Granville, a western industrial suburb of metropolitan Sydney, were from low-income families; while the children living at Pymble, a north-shore suburb, were from high-income families.

The two American samples were drawn from McCormick County, South Carolina and Gulfport, Mississippi. McCormick County lies on the south western boundary of South Carolina, across the Savannah River from Georgia. It had a total resident population of 7,955 at the 1970 census, of whom 3,151 or

39.6% were white, 4,800 or 60.3% were black and 4 or .1% were of other ethnic origin. The county seat of McCormick has a declining population in recent years as indicated both by census data as well as unoccupied business premises on the main street. The mean family income is $5,547; $6,722 for whites and $4,243 for blacks. McCormick County ranks 41st out of 46 counties in the state on family income level. The major industry of the county is textiles and wearing apparel manufacture with construction, lumber and wood products, and agriculture following. Compared with the national average, there is a low (2.6%) percentage of unemployment (.9% for whites and 4.2% for blacks). Schools provide classes for first through twelfth grades. There is no state supported kindergarten, but a Head Start Kindergarten has been operating in recent years. Children in McCormick are raised in a quiet, poor, somewhat isolated, rural environment, with little opportunity for travel or exposure to visitors or large-scale commerce.

Gulfport city has the biggest concentration of population on the 26-mile stretch of beach which accounts for most of the coastline of Mississippi State. It lies on the highway which at present provides the primary coastal road access from the southeastern states to New Orleans and the southwest. Of the 290,000 people living in the Gulf Coast Region, about 45,000 live in Gulfport (Wortman and Mann Inc., 1972). In recent years the annual growth rate has halved to 2.8% and the population shows a decline in number of preschool children and an increase in the young and retirement-age adults. There is a continuous, though so far uncrowded, succession of houses, motels, gas stations and occasional restaurants set among shady trees for several miles along the foreshore. Little unoccupied land is available which faces the four-lane waterfront highway. In the Gulfport city area there are houses continuously for several blocks inland. Industry in the city is growing rapidly; the employed labour force doubled from 1950 to 1970. The chief industry is support services for personnel at a nearby Air Force installation, but many find work in the deep-water harbour industries, in fishing or tourism, or in the retail trade of the business center. Though the average family income is low by national standards, at $7,800 it is higher than the Mississippi State average, and the growth rate is faster than either the State or the nation. The school system provides classes for grades 1 to 6 at elementary schools, grades 7 to 9 at middle schools, and grades 10 to 12 at high schools. Apart from a Head Start program, Kindergartens are not generally available. Although the 1970 census shows that the Gulfport population includes 18% of black people, the school system records 27% of the children as black. Children in Gulfport are raised in a moderately low income, semi-urban environment, with some exposure to commerce, tourism, and the usual seacoast environment.

McCormick and Gulfport are two of the communities where a Follow-Through program of compensatory education at primary-school level is in operation.[3] The number of children from each community in the Follow Through (FT) and non-Follow Through (NFT) programs are given in Table 1 (in the "Total" column), together with the numbers and percentages of these who are "low-income" according to the guidelines of the United States Office of Economic Opportunity.

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[3] For information concerning the University of Georgia model for early childhood education, write Dr. C. D. Smock, Mathemagenic Activities Program, Department of Psychology, University of Georgia, Athens, Georgia.

Table 1

Distribution of Ethnic Sample of Low-Income Children from McCormick and Gulfport, U.S.A.

		McCormick			Gulfport	
Sample	N	Total	%	N	Total	%
F Black	52	55	95	65	77	84
N Black	44	53	83	29	63	
F White	7	14	50	23	66	35
N White	8	32	25	10	69	15
	111			127		

F = Follow Through N = Non-Follow Through

Environmental Status Ratings

The environmental status for each of the 13 samples (Table 2) was based on the four variables (income, urban/rural, language, and home style), used in a prior study (de Lacey, 1972), and each rated on a four-point scale.

Table 2

Environmental Scale Ratings for the Thirteen Australian and American Samples

Sample	Income	Urban	Language	Home	Total
Aurukun Black	0	0	0	0	0
Alice Springs Black	0	1	0	0	1
McCormick FT Black	0	1	1	1	3
McCormick Non-FT Black	1	1	1	1	4
McCormick FT White	1	1	2	1	4
McCormick Non-FT White	2	1	2	1	6
Gulfport FT Black	1	2	1	2	6
Gulfport Non-FT Black	2	2	1	2	7
Alice Springs White	2	1	2	2	7
Gulfport FT White	2	2	2	2	8
Gulfport NFT White	2	2	2	2	8
Granville White	2	3	2	2	9
Pymble White	3	3	3	3	12

Cognitive Tests

Children of 6, 8 and 10 years of age were randomly selected from each of the 13 populations and administered two tests of cognitive ability; the Peabody Picture Vocabulary Test (PPVT) (an auditory verbal test) and the Nixon test of reclassification (based on Piaget's theory). The information on these tests and their reliability may be found in Dunn (1968), de Lacey (1972), and de Lacey (1970).

Results and Discussion

The obtained data from administration of the PPVT are presented in Table 3 and that from the Nixon test in Table 4.

Table 3

Mean Peabody IQ Scores for Children from Different Subcultures

		McCormick				Gulfport				Aurukun		Granville		Pymble	
		F		NF		F		NF							
Age	Race	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$	N	$\bar{X}$
6	B	20	70.0	17	71.3	20	80.9	20	87.4	10	48.7				
	W	8	89.1	15	91.2	20	103.6	21	107.1	10	96.1	10	95.9	10	111.7
8	B	17	75.9	19	80.8	28	84.0	20	87.8	10	69.9				
	W	5	74.6	10	101.2	26	100.3	19	101.3	10	84.2	10	93.7	10	116.0
10	B	18	71.1	16	70.8	23	79.5	20	90.2	10	58.8				
	W	2	94.0	7	97.7	20	100.0	19	105.9	10	74.8			10	121.3

F Follow Through
NF Non-Follow Through
B Black
W White

Table 4

Mean Nixon Test Scores for Children from Five Subcultures

		McCormick				Gulfport				Aurukun				Granville		Pymble	
		F		NF		F		NF									
Age	Race	N	X̄	N	X̄	N	X̄	N	X̄	N	X̄	N	X̄	N	X̄	N	X̄
6	B	20	2.00	17	1.72	21	2.72	20	2.55	10	0.72	20	2.20				
	W	8	2.84	15	2.44	20	6.00	20	3.25			10	2.61	10	2.10	10	4.68
8	B	17	2.48	19	3.68	28	4.47	20	4.50	10	1.98	20	2.22				
	W	5	2.60	10	4.72	24	5.49	20	5.45			10	2.32	10	4.32	10	4.98
10	B	18	5.29	16	4.69					10	3.12	20	3.63				
	W	2	6.00	7	5.47							10	3.80	10	4.62	10	5.70

F Follow Through
NF Non-Follow Through
B Black
W White

Standard deviations on the PPVT were about 12 IQ points, but ranged from 19.7 to 0 (in the sample of only two children). The standard deviations on the Nixon test ranged from 2.06 to 0 with the average 1.5 points.

Spearman's rank order correlation between the environmental ratings and the PPVT and Nixon scores separately are presented in Table 5.

Table 5

Spearman's ρ Correlations Between Ranks on the Environmental Scale and PPVT and Nixon Test Scores

	Age		
	6	8	10
Nixon	.68	.72	.45
PPVT	.90	.87	.83

The correlations, considering the rather crude environmental scale employed, are generally high, especially for the PPVT IQ scores. Further studies should lead to greater precision in identifying and describing the environmental variables associated with the development of specific cognitive skills. Especially important is the need for greater sensitivity of procedures for determining degree to which such variables are present in different communities. An improved interval, rather than an ordinal, scale of measurement and application of multiple correlation procedures between the environmental dimensions and patterning of cognitive abilities will probably tend to yield even higher associations.

The model proposed by Berry and Dasen appears to be appropriate for predicting cognitive skills from environmental conditions, even where the skills are as specific and ethnocentric as in the present study.

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Development of Concrete Operations in Urban and Rural Communities: A Study of the Effect of the Mathemagenic Activities Program[1]

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August, 1974

Prepared for the

MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH

of the

University of Georgia

Charles D. Smock, Director

This report is based on activities supported by the Mathemagenic Activties Program-Follow Through, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

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[1] The authors would like to thank the children, teachers, and aides of Lee County, Virginia, and Berkeley, California Follow Through Programs for participation in this study and a special thanks to Mike Holland and Pam Ebert for their assistance in preparation of this report.

PS 011512

Development of Concrete Operations in Urban and Rural Communities: A Study of the Effect of the Mathemagenic Activities Program

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Introduction

The relative effects of biological and social-cultural factors on cognitive development is a problem of continuing theoretical and practical interest to psychologists and educators. The comparative cultural experiment has been utilized increasingly in the past 15 years by investigators, particularly by those researchers interested in Piagetian theory (Goodnow, 1962; Gaudia, 1972; Goldschmid, 1968a). Two points of agreement emerge from these studies: 1) there is consistency in the order of acquisition of various conservation concepts; and 2) differences in the average age of acquisition of these concepts most plausibly reflect the impact of differential environmental contexts. The present report is part of a broad investigation designed to compare the interrelationships (structure) among concrete operations concepts[3] of children ages five to eleven years within (urban and rural) and between (Western and Eastern)[4] cultures.

Specifically, this study was concerned with a within-culture (USA) analysis of rural versus urban differences among Follow Through (MAP) and Non-Follow Through children during the stage of concrete operations. It is expected that the results of this analysis will be suggestive, at least, of the extent to which a cognitively oriented school instructional program (MAP-FT) contributes to the differential cognitive development of rural and urban children.

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[2] This study was completed while the senior author was a post-doctoral student at the University of Georgia. For further information regarding this report, the author may be reached at 155 & 157 Eisenhower Avenue, Teheran, Iran.

[3] "The (mental) operations involved in these problems are called 'concrete' because they relate directly to objects and not yet to verbally stated hypotheses....The essence of these structures...is to constitute progressive logical sequences involving various combinations of operations" (Piaget and Inhelder, 1969).

[4] The varying degrees of industralization, represented in the USA, France, and Iran, were the major criteria for differentiating Western and Eastern cultures.

Method

Subjects

Two hundred forty children, from seven through eleven years of age, participated in this experiment. One hundred twenty children were enrolled in two public schools in Berkeley, California (urban) and the remaining 120 children were from nine public schools in Lee County, Virginia (rural). There were 24 urban and 24 rural children in each age group. The children at ages seven, eight and nine were composed of 12 Follow Through and 12 non-Follow Through children in each school (Table 1).

Table 1

Distribution of Children in Each Age Group According to Sub-Cultural Context and School Program

		Age				
		7	8	9	10	11
Urban	FT	12	12	12	--	--
	NFT	12	12	12	24	24
Rural	FT	12	12	12	--	--
	NFT	12	12	12	24	24

All children except one in the rural group were white, whereas the urban group was comprised of 56% white and 44% black.

Procedure

Thirteen tasks developed by Piaget to study logical thought were presented to each child in the following order: conservation of discontinuous quantity, conservation of continuous quantity, conservation of weight, seriation of physical length, relative (length) position, intermediate position, double seriation, class inclusion I, transitivity of unequal lengths, all and some, class inclusion II, transitivity of unequal weights, and conservation of volume.

Each child was interviewed for about one hour. During this time the series of tasks was presented and questions asked in the form of variations (transformations) of the relationships between and/or among the tasks objects. The specific linguistic form of instructions differed for each task with repetition and/or rephrasing of statements in the child's vernacular when necessary to insure comprehension.

A. Tasks

1a. Conservation of Discontinuous Quantity (DQ)

Materials: 100 red wooden beads and four types of clear plastic containers (two 10-ounce beakers; one tall and one thin cylinder; a flat pie dish and a 1-ounce cup).

To test for conservation of discontinuous quantity, 100 small wooden beads were equally divided into two same-sized beakers. Equality was accomplished according to the child's criterion as the examiner and child simultaneously dropped beads one-by-one into the separate beakers until all were used. Beads from one of these beakers were then poured by the examiner into the tall cylindrical container. The child was asked "is the same amount of beads in this cylinder as is in yours, or does one have more or less than the other?" The child also was asked to explain why he thought the amount was (or was not) the same. After this justification, the child poured the beads back into the first ("his") beaker and the equality of amounts was reestablished. Beads from one beaker were then distributed equally into the five small cups. Again, the child was asked about their collective equality to the contents of the standard beaker, and was required to provide justification for his response. The cups were emptied back into the beaker, equality amounts was pointed out, and beads from one beaker then were poured out into a large flat dish. The same questions were repeated; but following the child's judgments and justification, contents of the standard (examiner's) beaker were poured into the tall cylinder to maximize perceptual discrepancy. The child was asked the "sameness" questions and for justification response for the relative amounts in the cylinder and dish and to prove by some action the sameness or inequality. The task was concluded with the child's emptying each of these containers into its original beaker.

1b and 1c. Conservation of Continuous Quantity (CQ) and Weight (CW).
Materials: two balls of clay, each approximately the size of a large egg and each a different color. A balance beam scale was used to equate weight.

In the conservation of weight and continuous quantity tasks, two colored balls of clay were equated, according to the child's judgment, for amount and weight (using a two-pan balance beam scale). One ball was successively transformed into a "snake," a "pancake," and into several (10 or 12) little balls. With each transformation the child was asked about the equality of the amount and weight of the altered shapes relative to the ball which had remained unchanged and to explain (or prove) the amounts and weights were the same. The child was allowed to verify his statement to see if he could apply the results.

Between each transformation test, the clay was re-rolled into a ball and weighed to demonstrate its constancy. For the final transformation, one ball was pressed flat into a very thin pancake while the other ball was rolled out into a snake form. No perceptual standard remained and the child was asked if the pancake had the same amount of clay as the snake or whether one had more. He was also asked whether, if each were placed on one end of the scale, one would weigh more, and why. How easy or difficult the child felt this task to be was considered in evaluating the child's conservation competence.

1d. Transitivity of Unequal Weights (TW)

Materials: three small opaque bottles of the same size and shape (1.5 ounces), two of the same color, but all three differing in weight and some pebbles.

Two of the bottles, each with pebbles inside, were weighed and then the lightest one was removed and replaced with a heavier one. The subject was asked, "Which one will be heavier, this 'last' one or the 'first' one? Since you haven't compared this (pointing) one to that (pointing) one, how do you know?"

1e. Conservation of Volume (CV)

Materials: two rubberbands, one ten-ounce beaker, one ball of clay, two opaque bottles and water.

The conservation of volume task began with one ball of clay and a beaker three-fourths full of water. The child was asked what would happen to the water level in the beaker if the ball was dropped in. His prediction was tested by marking the water level on the beaker with a rubberband and dropping the ball in. The amount of displacement was pointed out and the rubberband moved to the actual level. The child was asked to explain why the water rose and, if he failed, the examiner offered an explanation in terms of "taking room."

The clay was successively reshaped into a bar and a pancake and the child was asked to predict the water level if these new forms were submerged.

Following this, two small opaque bottles of the same size and shape but of different weights were presented. The child was allowed to lift each one to determine which was heaviest. The heaviest bottle was submerged, the water level marked with a rubberband, and the bottle removed. The child's task was to point out the water level if the lighter bottle were to be submerged.

His prediction was tested and he was asked to explain why the level rose the same amount.

The bottles were then removed and a clay ball reintroduced. This time the ball was separated into a handful of little balls. The child was asked to guess where the water level would be when all the little balls were submerged relative to the water level if all the little balls were still together in one large ball. The apparent confidence with which he reached a decision, and the degree of certainty of his justification were noted.

2a. Seriation (S)

Materials: ten cardboard dolls dressed in blue and white masculine clothing, with heights ranging from 10 through 19 cm.

The cardboard dolls were haphazardly scattered on a table. The child was informed the dolls were of different size and asked to "put them in order" from the tallest to the shortest. The child's operational understanding of seriation was next examined by questions on relative position (RP) and intermediate position (IP).

2b. Relative Position (RP)

A medium size doll was designated (by picking it up) and the child was asked how many dolls were taller and how many were shorter than this standard doll.

2c. Intermediate Position (IP)

An intermediate size (15.1 cm. tall) doll was given to the child to place in the appropriate slot in the series. If the child made a mistake, he was asked to check to "be sure" the doll was in the appropriate place.

2d. Double Seriation (DS)

Materials: ten walking canes from 5.5 through 11 cm. long and the

10 cardboard dolls of the above seriation task were used to test for double seriation.

The ten dolls were disarranged and the ten walking canes (in a group) were laid on the table. The examiner explained to the child that the longest cane belonged to the tallest doll and the shortest cane belonged to the shortest doll, and so forth. The child was to find which cane belonged to which doll and to arrange these object pairs from tallest to shortest. The behavioral strategy with which the child approached this task was carefully noted. Each child also was asked how he went about producing the correct matchings.

2e. Transitivity of Unequal Length (TL)

Materials: three cardboard dolls (14.6, 15.1 and 15.6 cm. in height) dressed in red, white and blue feminine clothes.

A blue and a white doll, 15.6 and 15.1 cm. tall respectively, were presented to the child and the height of the blue one (taller) was pointed out. The blue doll was removed and a 14.6 cm. high red doll was presented and compared by the child to the white one. After the child mentioned that the white doll was tallest, the examiner covered the blue one with her hand and asked the child which would be the tallest, the first (blue) or the third (red) one. The child was carefully questioned about how he reached his conclusion but the actual comparisons were not made.

3a. Class Inclusion I (FI)

Materials: Eight white and three yellow plastic roses.

After the child examined the flowers, they were placed on the table and three questions were asked:

1. "Are there more plastic flowers or more white flowers? The examiner then asked the child to "give me the plastic flowers" and

remarked "now there are no more flowers left on the table." The flowers were replaced and the procedure was repeated with the white flowers. The yellow flowers remaining on the table were pointed out to the child before returning the white ones. The examiner drew the conclusion for the child that "there are more plastic than white flowers."

2. "Now, if I make a bouquet with plastic flowers and then replace them so you can make a bouquet with white flowers, which bouquet will be bigger? Which bouquet will have more flowers?"
3. Questions #1 and 2 were then repeated.

3b. All and Some (A-S)

Materials: three types of blocks differing in color and shape (four red circles, two red squares and two green squares).

The blocks were randomly presented to the child with each being appropriately labelled as it was placed on the table. The following four questions were asked:

1. "Are all the circles red?"
2. "Are all the red things circles?"
3. "Are all the squares green?"
4. "Are all the green things squares?"

3c. Class Inclusion II (BII)

Materials: thirteen wooden beads, ten red and three blue, and two strings.

The procedure was exactly the same as with the flowers, except this time the beads and string were used in the hypothetical construction of a necklace (instead of a bouquet).

B. Scoring

Each child was categorized as a conserver, transitional, or nonconserver according to the complete set of responses to a given task. Positive (conserving) responses indicated accuracy and stability in reasoning, usually supported by expressions by the child indicating a feeling of "logical necessity." Transitional responses were characterized by a mixture of perceptual and operational based reasoning that was unstable and abandoned when confronted with the counter suggestions of the examiner. Negative (nonconserving) reactions were incorrect responses which lacked a logical basis and/or were determined only on perceptual appearances. For the purpose of statistical treatment, a score of 2 was assigned to a positive, 1 to a transitional, and 0 to a negative response. For the "all and some" task, a score of 1 was given for each correct answer so the total possible positives for this task was 4 rather than 2. Table 2 indicates the general scoring criteria for each level of response to the tasks.

Table 2

Scoring Procedures

Score	Response
0	Child responded incorrectly, lacked logical reasoning, and seemed to make his response on "how things looked."
1	Child responded correctly, but showed a mixture of logical reasoning and reliance on how things appeared. He could easily be led to make an incorrect response if the appearance of the object was emphasized.
2	Child responded correctly and revealed accurate and stable reasoning abilities even when the appearance changed drastically.

The scoring criteria for each type of task are elaborated below:

a. Conservation tasks. The conserver demonstrated an awareness that perceptual transformations alone do not alter logical relationships. Consequently conservers were resistant to visual discrepancies as well as to counter suggestions. In the conservation of volume task, conservers could not only correctly predict the water level displacement but also explained the phenomenon in terms of volume and not weight.

b. Seriation tasks. Positive reactions were scored for correct performance regardless of mistakes that were spontaneously corrected by the child. Either trial and error, or systematic comparisons, were acceptable if they produced the correct result and the child was "certain" of his answer. Negative responses were either totally confused pure guesses or certain but erroneous. The transitional child continued to make mistakes of which he was aware but which he could not correct.

c. Classification tasks. Reactions towards these tasks were categorized according to the adequacy of the child's understanding of the problem and his verbal explanation. Understanding of class inclusion and the relations between intension and extension were of paramount importance.

Table 3 summarizes the types of tasks presented to each child. The numbers in parentheses reflect the presumed order of development of the particular concept. The conservation of quantity, for example, would be expected to be successfully performed by a 7-year-old child, whereas conservation of volume is an ability expected to appear only after 9 years of age.

Table 3

Conservation	Seriation	Classification
Discontinuous (1) Quantity	Seriation (3)	All-or-Some (8)
Continuous (2) Quantity	Relative (4) Position	Flowers (9)
Conservation of (11) Weight	Intermediate (5) Position	Beads (10)
Conservation of (13) Volume	Transitivity of (6) Length	
	Double Seriation (7)	
	Transitivity of (12) Weight	

Results

The results of this study were analyzed qualitatively as well as quantitatively. Qualitative analysis, based on the *méthod clinique* developed by Piaget, explores the contents of the child's thought and focuses on the logic underlying responses on each task. Such an analysis provides one means for comparing developing strategies of logical thought.

Quantitative analysis provides an index for the comparison of both the level and structural evolution of logical thought between the urban and rural communities and between school program (Follow Through vs. Non-Follow Through) within each of those communities.

Qualitative data. Generally there were no observable differences with respect to the nature and form of the rural and urban children's responses to any of the tasks. A common developmental pattern seems to characterize the problem-solving behavior of children across *tasks* and *grade* levels, however.

Reactions to the conservation tasks were quite similar to those described by Piaget and Inhelder (1963). Statements exemplifying "perceptual" reasoning were frequent in the younger children. For example, "Ball will be a little bit heavier because this is a whole ball"; "The snake takes more room because it is bigger." Operational level reasoning of the older children referred to properties of reversibility, identity, compensation, and transformation: e.g., "This is the same amount of clay you rolled"; "You didn't add"; "This is the same weight because it is the same amount of clay that you used"; "Because we can make again the ball -- you just changed the shape; it's always the same amount"; "It (bottle) is heavier but it doesn't take any more or less space, just the same"; or "It should rise as much because it is the same amount of clay; it is the same piece."

Three types of explanation were offered concerning the displacement of water: descriptive, dynamic and volumetric. Dynamic explanations involved concepts of weight or pushing such as "It pushes and some of the water goes up"; "Water is moving when something heavy is in, like when I go skiing."

Three different strategies for constructing serial order (Seriation tasks) were evident:

1. Grouping two elements together regardless of size or any other systematic relation.
2. Trial and error, unsystematic perceptual comparisons. Children trying this approach often had difficulty understanding relative position and frequently felt that it was necessary to compare the middle doll with the closest ones to find the correct answer.
3. Active and systematic comparisons such as looking, each time, for the tallest or shortest remaining dolls.

Four general approaches to the double seriation task were noted:

1. Two element groupings.
2. Progressive and simultaneous trial and error comparisons of dolls and canes.
3. Construct a series of dolls (or of canes) and then look for the corresponding elements from the unordered set.
4. Construct a separate series of dolls and canes and then match corresponding elements across each series.

Strategy 1 was scored as a negative reaction. Strategy 2 was considered transitional if it produced an erroneous construction but positive if it resulted in a correct solution. Strategies 3 and 4 were scored as positive.

The nonconserving child was unable to coordinate the results of the two actions (in the transitivity tasks) which he performed in order to predict the result of a third comparison. Sometimes a correct prediction of the result was made but a correct reason, even when aided by the examiner, could not be given. Hesitancy and inconclusiveness was typically expressed as "I guess," or "I don't know." The conserver, on the other hand, easily referred to the middle term, sometimes with a very clear feeling of "logical necessity" based on reasoning such as "If the blue doll was taller than the white one and the white one is taller than the red one, then the red one has to be shorter than the blue one."

Again, rural and urban children appeared to respond in much the same way on the class inclusion tasks. The main difference was between the child who distinguished the whole class (i.e., plastic, flowers or wooden beads) from the subclasses (e.g., red, blue) and those who did not. The fact that the children "knew" all the flowers were plastic actually made it more difficult for many young children to abstract the whole class concept plastic while the perceptual configuration of white and yellow was predominant. Some children would not even admit the concept of artificial flowers as a defined whole because there were only "white and yellow artificial flowers." The common difficulty was in mental reconstruction of the superordinate class when it was physically separated into the two subclasses. The non-conserver could not simultaneously conceive the whole class and both subclasses; the former disappeared mentally, leaving only the two subclasses. An example of such thinking is "The bouquet with white flowers will be bigger because there are more white flowers than yellow ones."

A conserver, on the other hand, clearly could operate with the superordinate "whole" which predominated the configuration of subclasses; e.g., as he saw it, the bouquet with plastic flowers would be bigger because "all of the flowers are plastic and just some of them are white."

Quantitative Data. The mean and standard deviations for each task[5] across all five age levels are presented in Table 4.

Table 4

Average Scores Combined Across All Ages

For Each Task and Community

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ (1)	1.64	.69	1.89	.50
CQ (2)	1.48	.78	1.78	.56
Ser (3)	1.62	.69	1.91	.30
BP (4)	1.45	.90	1.80	.60
IP (5)	1.37	.93	1.62	.79
TL (6)	1.31	.95	1.83	.55
DS (7)	1.41	.72	1.60	.59
F(I) (9)	.80	.95	1.17	.98
B(II) (10)	.71	.95	1.33	.93
CW (11)	.94	.98	1.31	.85
TW (12)	.84	.98	1.43	.90
CV (13)	.30	.57	.57	.76

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[5] The All and Some task was excluded because the scoring differed from all other tasks.

Inspection of Table 4 reveals the mean score for urban children (1.20) was consistently higher than that of the rural children (.67) and typically showed less variance.

Analysis of variance was used to determine the relative effects of age, communities and tasks. The results (Table 5) indicate significant main effects of age, community and tasks (all at $p < .001$) as well as an interaction of communities and tasks ($p < .01$).

Table 5

Analysis of Variance of Conservation Scores

Comparing Age, Communities and Tasks

Source	df	MS	F
Ages (A)			20.12**
Communities (C)			38.03**
Tasks (T)			18.99**
C x T			3.22*
A x T			1.44
A x C			1.23
A x C x T			1.13

*$p < .01$

**$p < .001$

Further examination of the data clearly supports the notion that evolution of logical thought is complexly determined by environmental context. Figure 1 indicates when results are considered across all ages, transition stage responses (< 2 > 1)[6] are manifest on all tasks except conservation of volume for the urban children, but the rural children obtain an average below the mean transition scores on five of the tasks.

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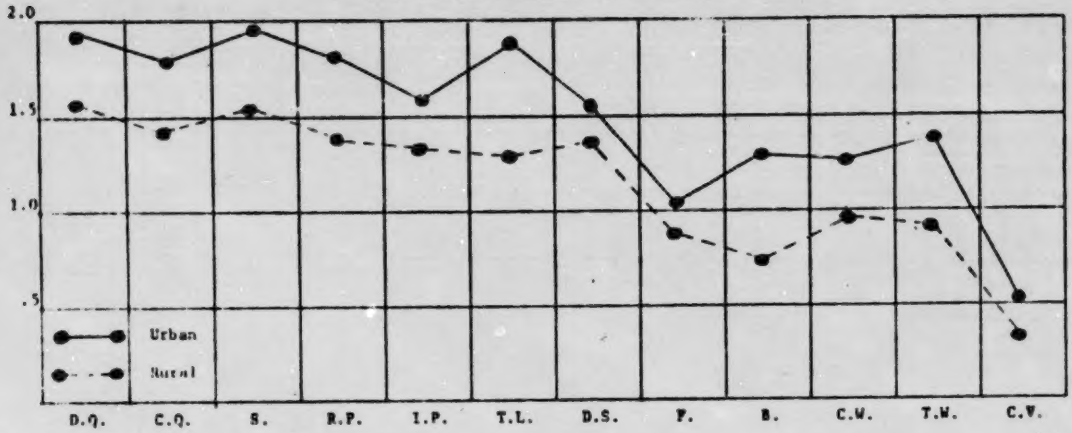
[6] Refer to scoring system on pages 9-10 and classification scheme on pages 3-8.

Figure 1

Average Score of Each Task Across All Ages,

Urban vs. Rural Differences



Comparison of task performance at the different age levels yields findings of considerable interest. In Tables 6 through 10, each mean raw score presents an average for 48 (24 rural and 24 urban) responders for each age level.

Table 6

Average Score for Each Task at Age 7

for Rural and Urban Children

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ	1.08	.92	1.79	.50
CQ	1.00	.83	1.62	.71
Ser	1.25	.89	1.75	.53
RP	1.17	1.01	1.50	.89
IP	.92	.93	1.25	.99
TL	.75	.98	1.58	.82
DS	.91	.82	1.20	.72
F(I)	.25	.67	.75	.98
B(II)	.25	.67	.75	.98
CW	.33	.63	1.12	.89
TW	.16	.56	.91	1.01
CV	.00	.00	.25	.53

Table 7

Average Score for Each Task at Age 8

for Rural and Urban Children

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ	1.50	.83	1.79	.58
CQ	1.29	.90	1.54	.77
Ser	1.37	.89	1.91	.28
RP	1.08	1.02	1.75	.68
IP	.92	.93	1.42	.93
TL	1.25	.98	1.66	.76
DS	1.20	.72	1.37	.64
F(I)	.25	.60	.70	.95
B(II)	.58	.92	1.12	.99
CW	.83	.91	1.08	.97
TW	.75	.98	1.00	1.02
CV	.20	.41	.20	.58

Table 6 indicates, that at age 7, the urban children manifest transition responses (< 2 > 1) on eight tasks as compared to four tasks for their rural counterparts. The 8-year-olds (Table 7) produced a greater number of transitional level responses as compared to those pupils at age 7. However, the urban children again have relatively more transition task scores than their rural counterparts.

Tables 8 and 9 provide the relevant data for the nine- and ten-year-olds.

Table 8

Average Score for Each Task at Age 9 for Rural and Urban Children

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ	1.83	.38	1.87	.44
CQ	1.62	.76	1.87	.44
Ser	1.79	.50	1.95	.20
EP	1.75	.68	1.63	.57
IP	1.67	.76	1.67	.76
TL	1.41	.92	2.00	.00
DS	1.54	.65	1.62	.57
F(I)	.91	1.01	1.25	.98
B(II)	.91	1.01	—	—
CW	1.08	.92	1.20	.83
TW	.91	1.01	1.66	.76
CV	.25	.49	.58	.79

Table 9

Average Score for Each Task at Age 10 for Rural and Urban Children

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ	1.91	.28	2.00	.00
CQ	1.79	.62	2.00	.00
Ser	1.79	.41	2.00	.00
EP	1.50	.84	2.00	.00
IP	1.50	.88	1.83	.57
TL	1.41	.92	2.00	.00
DS	1.62	.57	1.91	.28
F(I)	.83	1.00	1.66	.76
B(II)	.66	.96	1.66	.76
CW	1.00	.88	1.541	.72
TW	.87	.99	1.83	.56
CV	.33	.56	.95	.80

With the exception of one task, the urban students perform on the average at the later transition response level on all tasks employed. For the rural children, however, four tasks yield a mean score below that accepted (i.e., < 1.0) as a "transition" judgment and only three are above 1.75.

As Table 10 indicates, of the students at age 11 tested, a fairly similar pattern of performance by both urban and rural children at this age level is noted. The fewer number of conservation responses for the eleven-year-old urban, as compared to their ten-year-old counterparts, most plausibly reflects motivational differences on the "easier" tasks. This suggests either that the developmental lag evident in the rural group prior to age 11 has been overcome or that a "ceiling" effect is operating as the children near the end of the concrete operational stage.

Table 10

Average Score for Each Task at Age 11 for Rural and Urban Children

Tasks	Rural		Urban	
	Mean	sd	Mean	sd
DQ	1.87	.44	2.00	.00
CQ	1.79	.50	1.87	.44
Ser	1.91	.40	1.95	.20
BP	1.75	.68	1.91	.41
IP	1.83	.57	1.92	.41
TL	1.75	.67	1.91	.40
DS	1.79	.50	1.91	.28
F(I)	1.33	.96	1.66	.76
B(II)	1.25	.98	1.70	.64
CW	1.45	.72	1.62	.71
TV	1.50	.88	1.75	.67
CV	.70	.85	.87	.79

The detailed information provided in the above tables may be summarized as follows:

(1) There is a considerable consistency in the relationship among tasks in terms of level of difficulty at each age level and across all ages in both communities.

(2) There is an evolution of cognitive abilities evident in the score changes from one age level to the next in both communities.

(3) In general, at each age level, the rural children lag behind the urban children on all tasks.

(4) By age 10 and 11 the differences in level and pattern of cognitive abilities appear to be minimal which may be due either to a "ceiling" effect on the tasks or the Follow Through program, erasing the earlier cognitive developmental lag of the rural children.

To what factors of the environment may we attribute these differences in cognitive abilities when rural/urban environments are compared? To answer this question, we must consider the nature of the tasks employed and the milieu factors which might be operative within the communities involved in this study.

Piagetian tasks go beyond specific skills traditionally tapped by achievement measures and concern more directly the internal intellectual mechanisms and modes of coping with reality; i.e., to the evolution of rules of logic and the system of relations among intellectual functions. What, then, are the possible aspects of the environment which are salient for producing internal structural development? One such factor is schooling. In a previous study by N. Mohseni four- to ten-year-old schooled and unschooled children from both rural and urban areas in Iran were compared on several conservation tasks (mass, weight, liquid and volume) and several performance tasks; e.g., the Porteus and Goodenough tests. A difference of about two and two-and-a-half years in age of achievement of conservation was found between the rural and urban samples, even though the rural children were quite "schooled." The difference on the performance tasks was much more evident for the children four to five years of age. Thus, not only schooling effects, but the total subcultural characteristics of the contrasting milieus seemed to have different effects and to intervene differentially (de Lacey and Smock, 1974b) according to the nature of the mental activity required by the tasks. Of course, education facilitates certain kinds of skills but it should be considered as only one factor out of many within a given environment and, further, the quality of education may be quite different from one environment to another.

A second major factor is the extra-school physical/social experience (Goodnow, 1966; Goodnow & Bethon, 1966; Greenfield, 1966; de Lacey and Smock, 1974a). There appears to be a relatively larger "lag" of rural children on achievement tests as compared to these conservation tasks. This differential decrement may well stem from differences between environmental support for specific actions and that of support for more general coordination of practical and mental actions. Specific actions or skills often depend directly on "provocation" (highly specific aspects of the environment) and specific kinds of experience, whereas coordination of actions is more often the result of abstractions from more spontaneous activity of children in less structured physical and social environments. In other words, the abstractions derived from "spontaneous" activity represent fundamentals common to the cognitive structures underlying the different tasks.

The relative slow-down of evolution of these general coordinations of action in the sample of rural children in this study could be related to the lack of social exchange with adults and other children. In brief, the rural children might have a general lack of physical and social situations which provide opportunities for actions to be elicited and organized in a variety of contexts. A similar lack of opportunity applies to certain primitive cultures, whether Western or Eastern.

The Follow Through Program, as a compensatory education program for the "disadvantaged," attempts to provide comprehensive education in a more individualized, but socially active, setting. Further analysis was performed to determine if the type of school experience had any effect on the cognitive developmental progress of the rural and urban children.

The mean conservation scores, at each of the three age levels, for the Follow Through and Non-Follow Through children from the Urban community are presented in Table 11 and the comparable data for children from the Rural community in Table 12.

Table 11

Mean Conservation Score on Each Task for 7, 8, and 9 Year Old Urban Children in Follow Through and Non-Follow Through Programs*

Task	Age 7		Age 8		Age 9	
	FT	NFT	FT	NFT	FT	NFT
DQ (1)	1.83	1.75	1.67	1.92	2.00	
CQ (2)	1.58	1.67	1.67	1.42	1.42	
Ser (3)	1.83	1.67	1.92	1.92	1.92	
RP (4)	1.50	1.50	1.83	1.67	1.83	
IP (5)	1.00	1.50	1.50	1.33	1.67	
TL (6)	1.50	1.67	1.67	1.67	2.00	
DS (7)	1.08	1.33	1.25	1.50	1.67	
R(I) (9)	.67	.67	.50	.83	1.50	
B(II) (10)	.67	.83	1.17	1.08	1.67	
CW (11)	1.08	1.17	1.25	.917	1.42	
TW (12)	1.17	.67	.83	1.17	1.50	
CV (13)	.167	.33	.083	.33	.67	

*Note: All urban NFT pupils age 9 were in Grade 4; hence, not included as appropriate comparison group.

Table 12

Mean Conservation Score on Each Task for 7, 8, and 9 Year Old Rural Children in Follow Through and Non-Follow Through Programs

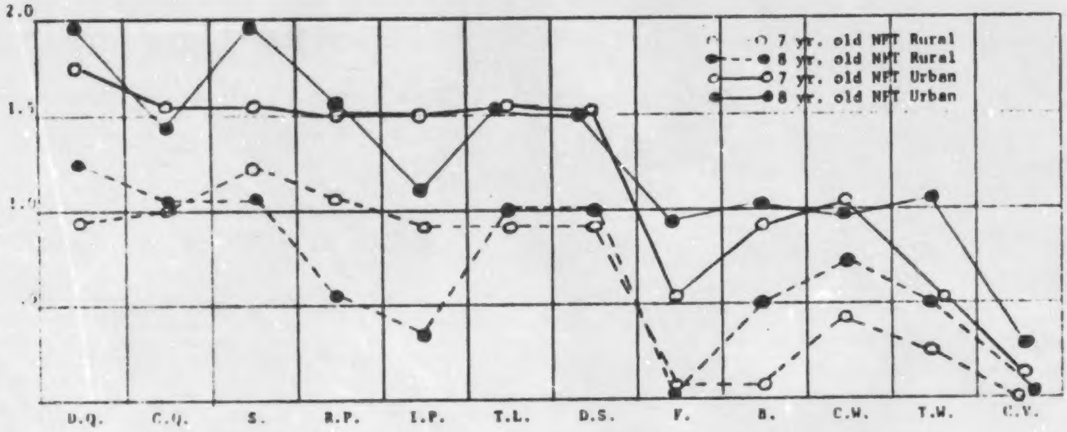
	Age 7		Age 8		Age 9	
Task	FT	NFT	FT	NFT	FT	NFT
DQ (1)	1.25	.916	1.75	1.25	1.67	2.00
CQ (2)	1.00	1.00	1.50	1.08	1.58	1.67
Ser (3)	1.25	1.25	1.67	1.08	1.75	1.83
RP (4)	1.17	1.17	1.50	.67	1.67	1.83
IP (5)	1.25	.83	1.50	.33	1.67	1.67
TL (6)	.75	.83	1.50	1.00	1.00	1.83
DS (7)	1.00	.83	1.42	1.00	1.42	1.67
F(I) (9)	.25	.17	.42	.08	.67	1.17
B(II) (10)	.33	.17	.67	.50	.83	1.00
CW (11)	.25	.42	1.00	.75	1.08	1.00
TW (12)	.00	.25	1.00	.50	1.00	.83
CV (13)	.00	.00	.25	.17	.17	.33

Statistical analysis indicated that in each community the Follow Through children (FT) performed significantly better on some tasks than their Non-Follow Through (NFT) counterparts, and vice versa. The patterning of these differences are of both theoretical and practical interest.

For example, comparison of Rural and Urban NFT children at the ages of 7 and 8 years (Figure 2) from the two communities clearly indicates the non-Follow Through Urban children score consistently higher than their rural counterparts on all tasks and the patterns of performance is highly similar for both age levels.

Figure 2

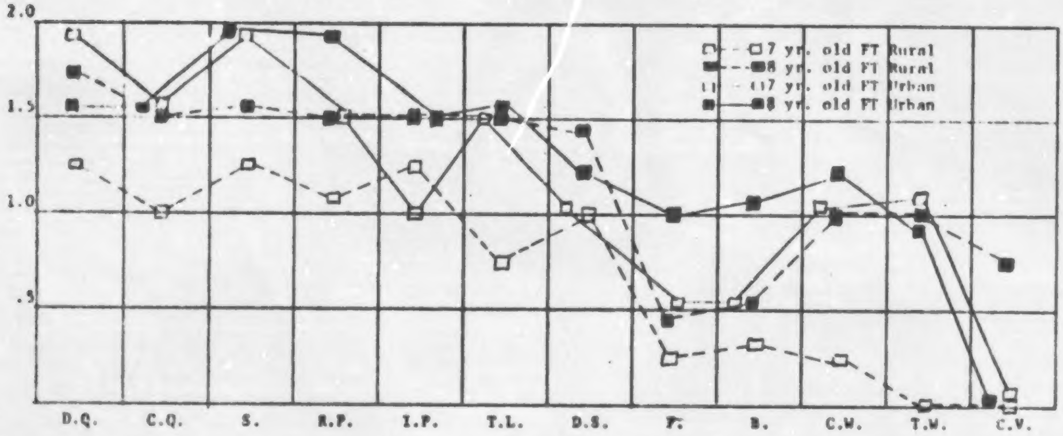
Comparison of NFT Rural and NFT Urban Children
At Ages 7 and 8 on Problem-Solving Tasks



However, the Follow Through-MAP intervention program seems to modify this difference between the rural and urban groups. Figure 3 indicates the 7 year old rural FT-MAP children do not perform as well as the urban FT children of the same age, but the urban and rural FT children show remarkably more comparable performance across all tasks at age 8.

Figure 3

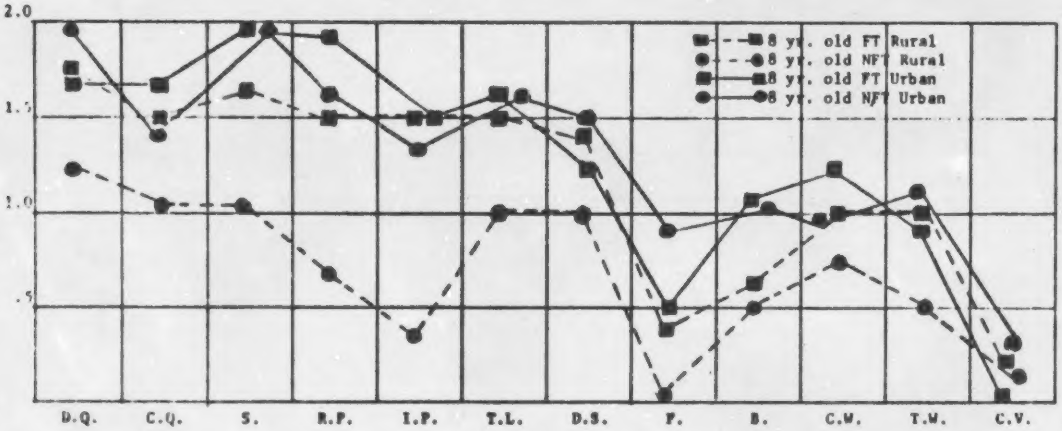
Comparison of FT Rural and Urban Children
At Ages 7 and 8 on Problem-Solving Tasks



Are the 8-year-old urban FT children simply falling behind the NFT urban children, or are the rural FT children really performing relatively better? Figures 4 indicates that the urban FT children continue to perform like their urban NFT counterparts at age 8; but that the rural FT children perform better across all tasks than their NFT counterparts of the same age group.

Figure 4

Comparison of FT and NFT Urban and Rural Children
At Age 8 on Problem-Solving Tasks

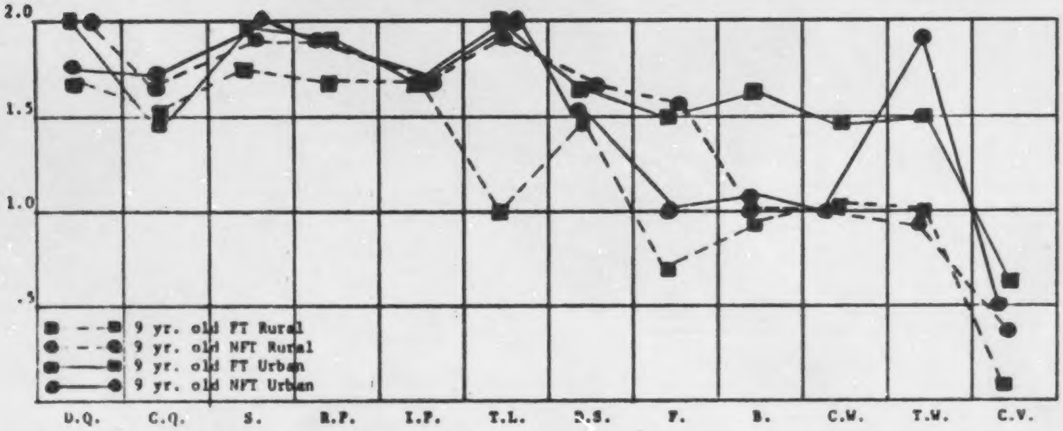


It would seem, therefore, that at age 8, the similarity of the performance of the rural FT children to the performance by the urban FT pupils occurs because the rural FT 8-year-olds are performing relatively better than their NFT counterparts.

At age 9, however, the rural FT children fail to perform as well as their urban counterparts on those tasks representing the more advanced cognitive-development level (Figure 5).

Figure 5

Comparison of FT Urban and Rural Children
At Age 9 on Problem-Solving Tasks



However, it should be noted that these children were in the Cohort I sample (i.e., first group of children and teachers in the program) of the FT-MAP program whereas the 8-year-olds had more experienced teachers and two years in the MAP curriculum. If the suggested program impact is stable, then the difference should be less (or reversed) for those 9-year-old children in Cohort III and/or IV who will have experienced the most mature MAP program.

To summarize, differences between rural and urban children on conservation task performance are most apparent in the Non-Follow Through sample of children in this study. The FT intervention program seems to eradicate these differences, at least as reflected in the performance of the 8-year-olds from both communities who were in the program for both the first and second grade levels.

Discussion

Both qualitative and quantitative analysis indicated highly similar profiles of cognitive achievements for rural and urban children but the urban children appeared to be slightly more advanced on all tasks at each age level employed. The type of school program emerged as an important contributor among those many factors that influence differences in cognitive abilities of rural and urban children.

The Follow Through classrooms of the Mathemagenic Activities Program (MAP) emphasize activity-based learning, increased peer interaction, and a high adult-to-pupil ratio. It was expected that these factors would be facilitative of the general intellectual growth of children and the present study is suggestive that such is the case. Performance on a series of Piagetian tasks, designed to reveal the growth of logical thought, yielded a developmental trend in the acquisition of the various concepts involving conservation, seriation, class inclusion and inferential reasoning. Differences in the age of acquisition of these concepts appear to reflect the impact of differential environmental context. The within-culture comparison of milieu effects on the development of logical thought yielded the expected differences between rural and urban contexts, but also the type of school curriculum (e.g., MAP) was a significant factor accounting for some part of this difference in developmental rate.

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Development of Social Relations: Role-Taking Skills and Classification Abilities

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January, 1975

Prepared for the

MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH

of the

University of Georgia

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PS 011512

This report is based on activities supported by the Mathemagenic Activities Program-Follow Through, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

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Preface

Follow Through as a federally funded Research and Development program is designed to determine the effect of planned variations of educational experiences (different types of classroom "models") on the learning process for young children. It is a "comprehensive" educational program concerned with all aspects of child development, but special emphasis is placed on the school learning environment and parent involvement. Variations in the classroom process and curriculum are the primary dimensions along which sponsor models differ. The national evaluation program, conducted by Stanford Research Institute (SRI), clearly indicates that sponsor differences do exist and that these different educational practices produce differential effects on the children (at least during K and 1). The "outcome" that has received the most attention is, of course, academic skills as measured by standardized tests. It is clear, however, that personal-social and general cognitive factors are also differentially affected by variations in teacher strategy and curriculum. The MAP model is designed to promote general intellectual and social development and it is the effects of the program on these two dimensions of child growth that concern us in this study.

In our view, the investigation reported here is the type of research and evaluation needed in education. That is, the study was designed to explore a theoretical idea concerning the nature of intellectual growth and its relation to social behavior and, at the same time, to evaluate the impact of a specific set of classroom practices on these psychologically based processes. Role-taking skills are considered fundamental to the development of interpersonal relations and to communication skills. Through studies such as this, we hope to gain more understanding of the contributions that school learning can make to both the rate and final level of development of competencies in these aspects of the child's development.

Development of Social Relations:
Role-Taking Skills and Classification Abilities

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Introduction

Piaget's theory of cognitive development may be described as structuralist and transactionalist. It is structuralist in its description of the organization of the consequences of the child's mental and physical operations (i.e., thinking and reasoning), and it is transactionalist in holding that advances in cognitive development come about through the interaction of the child's existing cognitive structures (accommodation) of the physical and social environments with structures of the environment as it is presently experienced (assimiliation). Advances in cognitive development are, in the theory, facilitated by opportunities for interaction that promote conflict between these structures. In this study three types of questions are raised about Piaget's theory:

1. Is performance on a social role-taking task dependent on the type of mental operations required?

2. What is the relation between the acquisition of social role-taking and classification ability?

3. What are the effects of variation in schooling environments on the acquistion of cognitive structures underlying the understanding of those aspects of the physical and social environments?

Studies on the structural reorganization of the child's understandings of social events have been reported by Feffer and Gourevitch (1960), Flavell Botkin, Fry, Wright and Jarvis (1968), and Chandler and Greenspan (1972). Some of the tasks used require subjects to differentiate their understanding of a cartoon sequence (shown first) from another person's understanding of only part of the same sequence (shown later). Thus, the subject's ability to role-take is inferred from the statements he attributes to another person, if that person were asked to describe the beginning, having been shown only the end of the sequence.

Egocentric errors are defined as "references to privileged information" which only the subject knows because only he experienced the beginning of the sequence. Flavell et al. (1968), using a cartoon task of this type reported that egocentric errors decreased with increases in grade level and suggested that the ability to perform this type of task appears to be completed by age 9 or 10; the same age was reported to be critical by Feffer and Gourevitch (1960). Chandler and Greenspan (1972) using a slightly different type of cartoon task found that 85 percent of the six-year-old children were egocentric as compared to four percent of the 13-year-olds. The reported similarities of the process of acquisition of role-taking and the description of a child's emerging concept of right and left by Piaget (see Elkind, 1961) are evident: (1) the child is initially unable to judge which is the right and which is the left hand of an experimenter sitting opposite; (2) the child understands the difference but makes frequent errors in judgment; (3) the child can make the transformation when thinking "carefully"; and (4) the child can make this transformation with ease. In recent formulations of Piaget's (1970, p. 710) theory, there is explicit emphasis on understanding these developments in terms of the process of decentration.

A recurrent problem with prior research in social role-taking is the manner in which qualitative structural variables are analyzed quantitatively. Quantification may be statistically advantageous and at the same time obscure the nature of the changes in the child's thought (Wohwill, 1973). The hierarchical nature of structural development proposed by Piaget implies that the order of acquisition of particular structures is fixed. Investigations into the relations between structures at a particular level of organization require careful analysis of the conceptual structures necessary to the solution of the tasks used. To date, many investigations into the relations between co-developing structures at the concrete operational level have regarded egocentrism as a trait. The demonstration of parallel development of such structures is supported by moderate positive correlations. Recent Genevan statements on the notion *structures d'ensembles*, however, emphasize the need to assess particular structures one by one. The vindication of *structures d'ensembles*, then, will come from studies demonstrating the logical interrelatedness of structures within a given level of organization (e.g. Wohlwill 1973, p. 200-204). In this context egocentrism refers generally to the inability to decenter in a particular problem at any level of cognitive development. Investigations into the notion of *structures d'ensembles*, therefore, must be specific about the presence or absence of the structures being studied. Thus, the importance of qualitative as well as quantitative measures of cognitive invariants follows.

All the measures of social role-taking derived from cartoons have required subjects to role-take in response to questions of the form "what happened before?" Decentered thinking in these tasks implies that the subject can perform an operation of exclusion on one of the possible meanings which may be attached to a particular picture in the cartoon sequence. In other terms, the subject can coordinate two meanings for part of the cartoon sequence and exclude "privileged information" while role-taking,because if someone else sees only part of the sequence, only part of the meaning will be known. However, in the process of looking at, and coming to understand cartoons, children naturally produce anticipations of what is going to happen next. Thus, the process of thinking about what another person would think was about to happen should be a more familiar mode of decentering than the mental operation which was required in prior studies (e.g., Chandler and Greenspan, 1972). In this study, cartoons were used which made it possible to ask subjects questions requiring both types of decentering. It is hypothesized that children would find "what happened next?" easier to decenter from than "what happened before?" in role-taking.

The second concern of this study is the relation between classification competencies and the ability to take another's social role. Piaget recently (1970) reaffirmed an earlier statement (1950) that the laws of thought (i.e., grouping) are nothing more or less than the various rules ensuring the reciprocity of "players" and the consistency of their "play." However, the way in which the young child's developing comprehension of his physical environment is related to similarly emerging understandings of his social environment remains to be made explicit and empirically verified. The literature on the changes from preoperational to operational thinking about the physical world is much more extensive than that describing parallel development in children's understanding of their social environment.

In fact, only Rubin (1973), Hollos and Cowan (1973), and Sullivan and Hunt (1967) have reported studies on the interrelations between these two sets of emerging concepts. Both the cartoon tasks and the classification tasks require the ability to coordinate "aspects" of the experienced problem. In both the cartoon sequence and in the classification tasks, the mental operations required are coordinations of parts of a whole. To determine whether or not the ability to coordinate is common to both types of tasks, the association between performance on the two must be examined at each grade level.[1] Quantitative analysis of data in investigations of how changes in young children's concepts of the physical environment relate to similar social environment concepts can render interpretation problematic.

The problem arises because it is

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[1] Neither the Rubin (1973) analysis nor the Hollos and Cowan (1973) study reported within-age analyses, though Rubin (1973) stated that this is desirable.

important to know what is being related to what in terms of the competence structures. For example, the study by Sullivan and Hunt (1967) reported no relation between Feffer's (1959) role-taking task and a measure of spatial egocentrism, but it is difficult to interpret this finding since quantitative data on each variable were dichotomized in an unspecified manner.

Finally, research on specific environmental determinants of cognitive competencies is an important aspect of the evaluation program associated with the University of Georgia Follow Through (MAP) Program. The MAP educational model is based on a constructivist view of knowledge acquisition; i.e., knowledge is acquired through opportunities for the child to autonomously organize experiences of mental and perceptual activity. Every effort is made, therefore, to provide children with theoretically appropriate educational experiences through a curiculum process emphasizing both small group and individual learning tasks. The social interactions which occur in small groups provide more frequent opportunities for the experience of contradiction necessary to the development of cognitive structures. The recommended curriculum materials make it possible for the teacher to set up a learning environment consistent with the MAP principles of: (a) mismatch, or appropriate structuring of the child's physical and social environment via learning units that are slightly above his present conceptual level; (b) self-regulation promoted by "learning territories" which encourage instructional strategies that provide for appropriate variation in modes of learning as well as balance between highly structured and relatively low structured learning situations and between group and individual learning activities; and (c) coordinated activities by which children learn by active manipulation of their physical, social, and symbolic environments. In addition, the "interlocking" nature of the different curriculum contents, (e.g., overlap of Science, Art, and Language) creates possibilities for development of intellectual processes and skills through a variety of media, activities and social situations. In its classroom structure, MAP requires two instructional aides, in order to provide a high level of social interaction in small group instructional situations.

It is suggested from previous studies that the MAP schooling environment facilitates the development of concepts of physical invariants in children in kindergarten through third grade (e.g., de Lacey and Smock, 1974; Mohseni and Smock, 1974; and Silverman and Smock, 1975). Thus, relative "acceleration" of cognitive development as indicated by performance on the role-taking and classification tasks might be expected among the children in the Follow Through Program.

In summary, the three major purposes of the present research are:

1. to investigate the effects of different types of mental operations on performance on social role-taking tasks;

2. to investigate the structural association between role-taking and classification abilities in the process of mental development;

3. to investigate the effects of age and educational program (Follow Through and non-Follow Through) on role-taking abilities and classification skills.

Method

Subjects

Ninety-seven children from three schools in Lee County, Virginia, served as subjects. Fifteen were in kindergarten, 26 in first, 28 in the second, and 28 in the third grade. Children were randomly selected from four classrooms (two Follow Through and two non-Follow Through) at grade levels one, two, and three. The kindergarten children were not randomly selected, but could be divided into those who had received compensatory education (Head Start) and those who had not. It was assumed that this would be comparable to the difference between FT and non-FT. Low income level subjects, as defined by OEO guidelines, were identified after data collection. The number of children tested by sex, income, grade level, and program (Follow Through versus non-Follow Through) are reported in Table 1.

Table 1

Number of Subjects by Grade, Sex, School Program, and Income

	Follow Through		Non Follow Through		
Grade Level	Boys	Girls	Boys	Girls	Total
Kindergarten*	1(1)**	5(4)	6(1)	3(0)	15
First Grade	7(3)	7(5)	6(0)	6(5)	26
Second Grade	7(3)	7(4)	7(4)	7(5)	28
Third Grade	6(4)	8(4)	7(7)	7(6)	26

*The kindergarten children were divided into FT and non-FT groups on the basis of whether or not they had Head Start experience.

**The number in parentheses indicates the number of low income children in each group: thus, the only KG boy to have received Head Start was low income.

The Follow Through Program

The FT Program has been in Lee County since the fall of 1969. At the time of this study, teacher training was the primary responsibility of project Resource Teachers trained by MAP staff and who have been working with the Program since 1969. The function of the Resource Teachers is to organize training programs for MAP-Follow Through teachers and to help facilitate implementation of the classroom process by frequent visits to each classroom. In addition, site visits by MAP classroom specialists (from the University of Georgia) were made five times during the academic year (1973-1974) in which this study was performed. The site visits included discussions with each teacher which focused on the degree to which the classroom reflected MAP principles. In short, while many efforts were made to ensure the fidelity of classroom environment with MAP principles, no objective measure of teacher effectiveness was available.

The classrooms from which the children were selected were randomly selected to be representative of FT and NFT classrooms in the community. One restriction on this random selection was that the FT classrooms were selected from available FT classrooms in one school but a post hoc analysis indicated these FT classrooms were quite representative of the FT classroom environments.

Experimental Tasks

Two Piagetian classification measures and seven social role-taking cartoon tasks were used. The Smedslund (1964) and Nixon (de Lacy, 1973) measures of classification ability were chosen to represent Grouping I and III of the concrete operational structures (Flavell, 1963). Five cartoons were modeled on a task (ID) used by Flavell, et. al. (1968), and two have been used by Chandler and Greenspan (1972).

Classification. In the Smedslund task the subject was shown thirteen red pieces of flat plastic, ten square (side 3/4") and three triangular (side 3/4"). In addition, there were six yellow pieces, three square (side 3/4") and three triangular (side 3/4"). The pieces were arranged irregularly on a white piece of paper (8 1/"x11"). The subject was asked a series of preparatory questions (1-9 below) and was corrected if an error was made. The preparatory questions were as follows:

(Experimenter points at a red square piece)

1. What color is this?
2. What shape does it have?

(Experimenter points at a yellow triangular piece)

3. What color is this?
4. What shape does it have?
5. Can you place all the yellow ones over here? (Points to one corner)

(When all the yellow pieces are removed, the experimenter points at the remaining red ones.)

6. Are all these ones red?

7. Are there more square ones or more triangular ones here?

(The red pieces are then covered with another sheet of paper.)

8. Are all the pieces here red?

9. Are there more square ones or more triangular ones?

Then the following test questions were asked: (with the red pieces covered)

10. Are there more red ones or are there more square ones?

11. How do you know that?

(Objects uncovered)

12. Now, look at them. Are there more red ones or more square ones?

13. How do you know that? (This question may be omitted when the answers to 10, 11, and 12 are correct.)

The responses were classified in three ways: (1) "more red ones because all the pieces were red" received a score of "three"; (2) "more red pieces" but unable to give a reason was scored "two" (a figurative response); and (3) "more square pieces than red pieces" was scored "one."

For analyses of these data, the subjects were classified as operational (score = 3) or preoperational (score = 1 or 2).

The Nixon task consists of five sets of painted wooden cylinders: one white set, one red set, one green set, one yellow set, and one blue set. Each colored set was made up of four pieces: a tall (2") fat (1") cylinder, a tall (2") thin (5/8") cylinder, a short (1½") fat (1") cylinder, and a short (1½") thin (5/8") cylinder.

The subject was seated at a small table opposite the experimenter. The examiner placed, on his left, a group of four rods: the tall fat red, the tall thin red, the short fat red, and the short thin red. He said, "These are all together because they are all red." Then a second group of four (tall fat green, tall thin green, short fat green, and short thin green) was placed a few inches to the right of the other group. The examiner said, "See, here is another group of rods which are all the same in some way. They are all green." Then, he picked up the tall fat red and the tall thin red and said, "These are the same except they have different 'fatness.' Now, I want you to make two groups out of all the blocks here so that one group is thin like the tall thin red one, and the other group is fat like the tall fat red one."

After the subject had completed this sorting, and the experimenter was sure it was understood that the sort was based on the different "fatness" of the blocks, the next example was given. The experimenter said, "Now do you see that we could take the tall fat red one and the short fat red one, and they would be different in their height? Now, I would like you to sort these blocks into two groups so that one group is short like the short fat red one, and the other group is tall like the tall fat red one."

After the demonstration, the experimenter began item one by placing the red cylinders and the white cylinders in front of him, going from left to right: the tall fat red cylinder, the short fat red cylinder, the tall thin red cylinder, and the short thin red cylinder. Having placed the red cylinders together, a space was made before placing the white cylinders together in a similar manner. Then the experimenter selected the tall thin red cylinder and the short thin red cylinder and said: "I would like you to put the ones which go with this one (indicating the tall thin red cylinder) here, and I want you to put the ones which go with this one (indicating the short thin red cylinder) here." The subject was given two opportunities to perform this grouping. If he grouped them incorrectly, the experimenter simply reintroduced the problem with reference to the tall, thin red cylinder and the short thin red cylinder. When the subject was satisfied with his response, the experimenter asked the subject why the blocks were grouped as he had grouped them.

There were six items in this test, which were all administered in the same manner. The items are presented schematically in Figure 1.

Figure 1

Display of Cylinders in Nixon Test

	Two Groups of Cylinders in Each Item		Problem
Item 1	TRF, SRF, TRN, SRN	TWF, SWF, TWN SWN	TRN, SRN
Item 2	TYF, TGF, TYN, TGN	SYF, SGF, SYN, SGN	SYF, SGF
Item 3	TWF, SWF, TWN, SWN	TBF, SBF, TBN, SBN	TWF, TWN
Item 4	TRF, TYF, SRF, SYF	TRN, TYN, SRN, SYN	TRF, TYF
Item 5	TGF, TBF, TGN, TBN	SGF, SBF, SGN, SBN	TGF, TGN
Item 6	TRF, TBF, SRF, SBF	TRN, TBN, SRN, SBN	TBF, SBF

Key: 1st letter (height): T = tall, S = short
2nd letter (color): R = red, Y = yellow, W = white, G = green, B = blue
3rd letter (thickness): F = fat, N = narrow

Subjects were classified as operational on each item of the Nixon test if they regrouped the cylinders on the first attempt and gave the correct reason for this arrangement (score = 3). Subjects who regrouped the cylinders correctly but gave no reason and subjects who classified the cylinders on the second attempt and gave a correct reason for this arrangement were classified as figurative (score = 2). A slightly stricter criterion for an operational response was used than that considered by de Lacey (1972) and by de Lacey and Smock (1974) in order to lower the probability of chance solutions. Subjects achieving no correct response on an item were scored "1". In subsequent analyses, responses to items were considered to be operational (score = 3) or preoperational (score = 2 or 1).

Role-Taking Tasks. The major difference between the procedures used here and those used by Flavell et al. (1968) was that two types of questions were asked after the subject's describtion of the cartoon sequence. That is, both a "next" question and a "before" question were asked whereas Flavell et al. (1968) used only the "before" question. Questions were designed to require a subject to recognize that if a "friend of yours" was shown part of the cartoon sequence, the friend would remain ignorant of details omitted from the story. On the next questions, subjects were asked what a friend might say if he saw only the beginning of the sequence and was asked to state "what happened next." The before questions involved showing the subject pictures only from the end of the sequence and asking what his friend would think if he were shown these pictures and then asked "what happened before." The types of stories limited the sorts of questions which could be legitimately asked; on only four of the seven cartoons could both the "next" and "before" questions be used. Descriptions of the cartoons are included in Appendix A.[2]

The role-taking tasks were introduced to the subjects as follows: "I am going to show you some cartoons, like comics in the newspapers, which I will ask you to describe to me. Some of the cartoons are about boys and girls, and the others are about little pigs. I will show you the cartoons one at a time and will ask you to describe what is going on. I am particularly interested in what is happening to the child or animals in the cartoons and in what they are doing. So that I won't forget what you say, I am going to record what you say on this tape-recorder.

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[2] Due to copyright difficulties, the actual cartoons cannot be presented in this paper. If the reader wishes to see them, however, please check the references listed.

Do you understand what you are suppoed to do?

Here is the first cartoon. Study it carefully. Look at each picture and remember to pay special attention to what is happening to the people, or animals, in the pictures, and also what they are doing...What is happening in the first picture?"

Giraffe Cartoon #1

After the subject had completed his initial descriptions of the 7 picture cartoon, the experimenter showed the subject pictures 1, 2, 3, 4, and 5 again, repeating the subject's story while doing this. [The pictures in each cartoon sequence were numbered as in the Appendix.] Then the following (next) question was put to the subject:

"If we brought _____ in now (_____ was one of the children in the subject's class who was not included in the experimental sample) and showed him these pictures (1 to 5), what do you think he would say was going to happen? Remember, he sees only these pictures."

Sometimes the subject's response indicated that he didn't distinguish between his own perspective and _____ 's perspective. At other times subjects said that they didn't know. The important thing was to find out whether the subject realized that _____'s understanding of the story was different because _____ had not seen "the real ending" to the cartoon. The care taken is critical since it is important not to give the subject the answer to the question being asked.

The Snowball Cartoon #2

After the subject had completed his initial description of the 7 picture cartoon, the experimenter showed pictures 1, 2, and 3 to the subject, repeating the subject's story while doing this. Then the following (next) question was put to the subject:

"If we brought _____ in now and showed him these pictures (1, 2, and 3), what do you think he would say was going to happen? Remember, he sees only these pictures."

When the subject had answered this question, and any others which were necessary to infer that the subject understood that there were different perspectives here, the subject was shown the last picture and the experimenter asked the following (before) question:

"If we brought _____ in, and showed him this picture (7) of snow falling on these two boys, and asked him why is the snow falling, or where did the snow come from, what do you think he would say? Remember, he only sees this one picture."

The Pig Rescue Cartoon #3

After the subject had completed his initial description of the 7 picture cartoon story, the experimenter showed pictures 1, 2, and 3 to the subject, repeating the subject's story while doing this. Then the following (next) question was put to the subject:

"If we brought _____ in now, and showed him these three pictures (1, 2, and 3), what do you think he would say was going to happen? Remember, he sees only these pictures."

When the subject had answered this question, the experimenter showed the subject the last picture in this sequence and asked the following (before) question:

"If we brought _____ in, and showed him this picture (7) of two pigs in a balloon flying over an island, and asked him whether the two pigs had come from the island, what do you think he would say? Remember, he only sees this one picture."

The Pig Falls Cartoon #4

After the subject had completed his initial description of the 5 picture cartoon story, the experimenter showed pictures 1 and 2 to the subject, repeating the subject's story while doing this. Then the following (next) question was put to the subject:

"If we brought _____ in now and showed him these two pictures, showing him pictures 1 and 2, what do you think he would say was going to happen to the pig? Remember, he only sees these two pictures."

When the subject had answered this question, the experimenter showed the subject pictures 4 and 5 and asked the following (before) question:

"If we brought _____ in now and showed him these pictures of the pig sitting in the snow, with the three bears looking at him, and we asked him how did the pig get there, what do you think he would say? Remember, he only sees these two pictures."

The Pig and the Wolf Cartoon #5

After the subject had completed his initial description of the 8 picture cartoon story, the experimenter showed the subject pictures 3, 4, and 5, repeating the subject's story while doing this. Then the following (next) question was put to the subject:

"If we brought _____ in now and showed him these three pictures (3, 4, and 5), what do you think he would say was going to happen? Remember, he sees only these three pictures."

When the subject had answered this question, the experimenter showed the subject the first and the last picture of this sequence and asked the following (before) question:

"If we brought _____ in now and showed him this picture of the pig going for a walk, and this picture of him walking about in the forest in the dark, what do you think he would say had happened? Remember, _____ only sees these two pictures."

The Chandler Tasks

After the subject had completed his initial description of the cartoon pictures, the experimenter began again with the picture which introduced the witness or bystander and said: "Now, I want you to begin again with this card (pointing to the first frame in which the bystander is introduced) and describe what is happening again, but this time I want you to tell me the story that the bystander (indicate) would tell. Try to pay special attention to what the bystander would believe the other people in the cartoon are thinking and feeling. Begin here and tell me what the bystander would say is happening in this picture. He would say..."

The subject's responses to each question were classified as egocentric when the subject attributed privileged information to the "person whose role was taken." Privileged information was defined as information which only the subject was supposed to know, i.e., because the "person whose role was taken" had not seen all the cartoon sequence. A description of sample egocentric and decentered responses for each cartoon is included in Appendix B.

Procedure

The Smedslund and the Nixon tasks were administered in that order by two trained examiners with each examiner individually testing approximately one half of the subjects. The cartoon tasks were administered by the first author and a trained research assistant, each testing approximately half of the subjects. The data from the cartoon tasks were recorded on cassette tape recorders and on specially prepared data sheets. These data sheets (see Appendix C) were organized to facilitate the administration of the tasks. In the latter stages of data collection the first author wrote down the subjects' responses to the cartoon tasks because one tape recorder was malfunctioning. All subjects received cartoon 1 first, then approximately half received the Chandler cartoons followed by cartoons 2, 3, 4, and 5; in this case, each of the latter cartoons was followed by a next question and then a before question. The other subjects received the Chandler cartoons after the other cartoons and the next and before questions were reversed in order.

The subject's responses to the role-taking questions were scored by the first author. The research assistant scored a random sample of nine subjects' responses (approximately a ten percent sample). Only four disagreements occurred in the 99 responses scored by both examiners. The disagreements were easily resolved in discussion.

Results

Role-Taking Ability

Five of the tasks used here were constructed for this study. Therefore, preliminary analyses were necessary to determine the degree of suitability of these cartoons as measures of egocentrism.

First, there were no significant order effects for any of the cartoon task variables.

Second, to establish the homogeneity of the tasks, the percentage overlap of egocentric responses on each pair of next questions and the before questions was separately determimed. For example, the 88% egocentric overlap between responses to next questions on the giraffe cartoon and the pig's fall cartoon (see Table 2) indicates that 28 of the 32 egocentric subjects on the giraffe

Table 2

Percentage Overlap of Egocentric Responses By Question Type*

Next Questions

	1	2	3	4	5
1. Giraffe cartoon	(32)**				
2. Pig and wolf cartoon	69%	(34)			
3. Snowball cartoon	72%	68%	(38)		
4. Pig rescues cartoon	78%	71%	68%	(43)	
5. Pig falls cartoon	88%	85%	76%	72%	(48)

Before Questions

	1	2	3	4	5	6
1. Chandler lost coin cartoon	(24)					
2. Chandler melting snowman	63%	(34)				
3. Pig rescues cartoon	63%	56%	(43)			
4. Snowball cartoon	71%	71%	74%	(49)		
5. Pig falls cartoon	75%	56%	79%	71%	(50)	
6. Pig and wolf cartoon	83%	74%	79%	86%	82%	(59)

* Percentage overlap for 2 cartoons = (The number of egocentric responses in the cartoon with the smaller number of each responses which are associated with egocentric responses on the other cartoon + number of egocentric responses in the cartoon with the smaller number of egocentric responses) X 100.

** Numbers in parentheses are the numbers of egocentric responses for a particular cartoon and question type.

cartoon also were egocentric on the pig falls cartoon. In comparisons overlap was defined then, as the number of times subjects gave egocentric responses to both cartoons divided by the number of egocentric responses on the cartoon with the smaller number of such responses. The obtained percentage overlap for both next questions and before questions suggest the cartoons and task procedures are suitable as a measure of the inability to decenter.

Additional evidence for the validity of the cartoons as measures of decentering is provided in the product-moment correlation matrices (Table 3) of the responses (egocentric and decentered) to the next questions on five cartoons, and to the before questions on six cartoons. Since the magnitude of all these intercorrelations is generally low and positive, it is possible that different pairs of intercorrelations are explaining different variances. It is important, for subsequent analyses, to know to what extent the questions on different cartoons are in fact measuring the same decentration process. The homogeneity of the pro-

Table 3

Intercorrelations Between Responses
to Next Questions and Between Before Questions

Next Questions

	1	2	3	4	5
1. Giraffe cartoon	1.00				
2. Pig and wolf cartoon	0.48	1.00			
3. Snowball cartoon	0.45	0.43	1.00		
4. Pig rescues cartoon	0.45	0.38	0.37	1.00	
5. Pig falls cartoon	0.53	0.50	0.39	0.40	1.00

Before Questions

	1	2	3	4	5	6
1. Chandler lost coin	1.00					
2. Chandler melting snowman	0.38	1.00				
3. Pig rescues cartoon	0.21	0.12	1.00			
4. Snowball cartoon	0.21	0.29	0.37	1.00		
5. Pig falls cartoon	0.25	0.02	0.50	0.34	1.00	
6. Pig and wolf cartoon	0.33	0.20	0.29	0.51	0.48	1.00

cess which the cartoons were measuring can be determined by the Ebel coefficient (Winer, 1971), which treats each cartoon as a "judge" of the subjects and provides an intercartoon reliability coefficient. The obtained correlation ($\underline{r}$=.82) can be interpreted as strong evidence that variance accounted for by the low product-moment correlations (between each pair of cartoons) is the same variance for each pair of cartoons (i.e., homogeneity of process).

Mental operations in role-taking

A question of importance to the understanding of role-taking skills is whether the conceptual operations involved in responses to the next type, as compared to the before type of questions, are distinguishable. On four of the cartoons both types of responses were elicited. The frequency of each type of response (egocentric and decentered) for the two types of questions (next and before) for each cartoon is presented in Table 4.

Table 4

The Effects of Next and Before Questions on the Ability to Decenter
(Numbers of Subjects Reported in Cells)

Snowball Cartoon

	Next	
Before question	**Egocentric**	**Decentered**
Decentered	10	31
Egocentric	28	21

Pig Rescues Cartoon

	Next	
Before question	**Egocentric**	**Decentered**
Decentered	12	32
Egocentric	31	12

Pig Falls in Snow Cartoon

	Next	
Before question	**Egocentric**	**Decentered**
Decentered	9	28
Egocentric	38	11

Pig and Wolf Cartoon

	Next	
Before question	**Egocentric**	**Decentered**
Decentered	4	26
Egocentric	29	29

In the interpretation of a cartoon sequence people anticipate endings frequently. However, the process of imagining a different beginning to a cartoon sequence is not a necessary part of cartoon interpretation. With this in view it was hypothesized that the subjects would find it easier to decenter from the next questions than from the before questions. Transitional subjects who are inconsistent (i.e., egocentric on one type and not on the other) should therefore be more often egocentric on before questions. McNemar (Siegel, 1956, pp. 63) tests for the significant of change indicate the results support the hypothesis for only two of the cartoons: snowball cartoon, $\chi^2(1) = 3.22$, $p < .05$, 1 tailed; pig and wolf cartoon, $\chi^2(1) = 15.61$, $p < .001$. When all task responses were considered, however, the hypothesis that transitional children find it easier to decenter from next questions was supported, $\chi^2(1) = 13.04$, $p < .001$.

Role-taking and classification abilities.

The relation between classification and role-taking abilities was analysed using χ^2 analyses or the Fisher exact probability test where more appropriate. First, 2x2 contingency tables were prepared contrasting operative and figurative responses on each classification task separately with decentered and egocentric responses on the role-taking tasks. The type of analysis performed was chosen to determine the association between the classification structures, which are unique for each task, and ability to perform role-taking. To arrive at an overall index of social decentering, subjects with four or more egocentric responses to the 11 role-taking questions were considered to be preoperational. Using this criterion, only 33 subjects (or 38%) manifested operativity on the cartoon tasks. This criterion was used on all qualitative analyses of the role-taking data. Second, 2x2 contingency tables were prepared contrasting operative responses on both classification tasks with decentered and egocentric responses on the role taking tasks. It was decided to categorize subjects with five or six (out of six) operational responses on the Nixon test as operational. Using this criterion 39 per cent of the sample were operational on this test. These data are reported in Table 5. The first set of analyses were performed both across and within grade levels, since both decentered responses on role-taking tasks and operational responses on classification tasks have been shown to increase with increases in age. Any association therefore, between role-taking and classification across grade levels is necessarily confounded with age.

Table 5

Frequencies of Subjects' Responses to Role-Taking Tasks and Classification Tasks by Grade Level and Classification Tasks

	KG		Grade 1		Grade 2		Grade 3		Across Grades	
Role Taking Ability	Egocentric	Decentered	Egocentric	Decentered	Egocentric	Decentered	Egocentric	Decentered	Egocentric	Decentered
Classification										
Task and Ability										
Smedslund										
preoperational	5	1	10	1	7	1	4	1	26	4
operational	2	1	8	6	11	9	10	12	31	28
Nixon										
preoperational	6	0	16	4	11	4	6	8	39	16
operational	1	2	2	3	7	6	8	5	18	16
Nixon and Smedslund										
preoperational	7	1	18	4	13	4	7	9	45	18
operational	0	1	0	3	5	6	7	4	12	14

There was a significant association between preoperational and operational responses on the Smedslund and egocentric and decentered responses to the role-taking tasks across grade levels, $\chi^2 (1) = 10.06$, $p < .005$, 1 tailed, but it was not significant within grade levels. Inspection of the data in Table 5 shows, however, that only one subject at each grade level was preoperational on the Smedslund task and decentered on the role-taking tasks. This would seem to imply that the acquisition of the ability to perform class inclusion operations of the type involved in this task is necessary but not sufficient for performing the role-taking tasks at an operational level.

The association between preoperational and operational responses on the Nixon classification task and egocentric and decentered responses to the role-taking tasks also were significant across grade levels, $\chi^2(1) = 2.95$, $p < .05$, 1 _tailed_, but not within grade levels.

In the second set of analyses between classification and role-taking ability the category of operational classification responses was restricted to those subjects who were operational on both classification tasks. These analyses also were performed both across and within grade levels. There was a significant association between operational and preoperational responses to the classification tasks and decentered and egocentric responses to the role-taking tasks across grade levels $\chi^2(1) = 5.103$, $p < .025$, 1 _tailed_. When these associations were considered within each grade level this association was significant only at grade one $p = .015$ (Fisher's exact probability test), and at grade two, $\chi^2(1) = 2.80$, $p < .05$, 1 _tailed_.

The Influence of the Follow Through Program

A preliminary question of concern about the classification data is that of the relation of age (grade level) to classification performance. These data, and those describing the relation between educational environment (FT and non-FT) and classification ability are summarized in Table 6.

Table 6

Types of Responses on the Classification Tasks by FT and NFT
(Numbers of Subjects in Cells)

	Nixon				Nixon and Smedslund				Smedslund			
	Figurative		Operative		Figurative		Operative		Figurative		Operative	
Grade Level	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT	FT	NFT
Kindergarten	6	5	0	3	6	7	0	1	4	6	2	2
Grade 1	9	10	5	2	11	12	3	0	7	5	7	7
Grade 2	5	10	9	4	6	11	8	3	4	4	10	10
Grade 3	6	8	8	6	8	8	6	6	3	2	11	12

The degrees of association between grade level (KG, 1, 2, 3) and level of performance (preoperational and operational) on classification was tested for significance using χ^2 analyses. The association between grade level and performance on the Nixon task was not statistically significant, χ^2 (3) = 5.16, $p < .25$. However, there was a significant association between grade level and performance on the Smedslund, χ^2 (3) = 10.71, $p < .025$, and for the stricter criterion of operativity on both tasks, χ^2 (3) = 11.30, $p < .02$.

The effects of the Follow Through program were investigated by contrasting the type of classroom learning environment (FT vs. non-FT) and level of response (operational vs. preoperational). On the Nixon test there were 46 percent of the FT sample who were operational as compared to 31 percent of the non-FT sample, but this difference, though suggestive, is not statistically significant, χ^2 (1) = 1.58, $p < .10$, 1 *tailed* No such trend between the FT and non-FT sample appeared on the Smedslund task (FT = 62%; non-FT = 64%). When the strict criterion of operational responding on both tasks was employed, the FT subjects were again superior to the non-FT subjects at a non-significant level, χ^2 (1) = 2.34, $p < .10$, 1 *tailed*.

In light of prior research, any interpretation of differences in the abilities of FT and non-FT children needs to take into account the social-income background of the children. The distribution of low income children in the FT and non-FT groups (Table 7) was approximately equal. Chi-square analysis yielded no statistically significant relation between income level and classification ability.

Table 7

Numbers of Subjects in Each Program, Grade and Income Level

	Follow Through		Non-Follow Through	
	Income		Income	
Grade	Low	High	Low	High
K	5	1	1	8
1	8	6	5	6
2	7	7	9	4
3	8	6	13	1

The influence of grade level, program, and sex on the number of egocentric responses elicited by all eleven role-taking questions was assessed using a 3 (grade) x 2 (program) x 2 (sex) analysis of variance. The relevant means and standard deviations are reported in Table 8 with a summary of the analysis of variance presented in Table 9.

Table 8

Means and Standard Deviations for the Number of Egocentric Responses on the Role-Taking Tasks for Grade, Sex, and Program (FT, Non-FT)

	FT		Non-FT	
	Male	Female	Male	Female
Grade 1				
$\bar{X}$	7.00	4.33	5.33	7.00
sd	3.79	2.16	4.46	1.27
Grade 2				
$\bar{X}$	5.57	4.14	4.57	8.00
sd	4.65	3.02	3.69	2.31
Grade 3				
$\bar{X}$	1.50	4.14	4.00	3.43
sd	1.38	2.41	2.71	3.36

Table 9

Analysis of Variance of Number of Egocentric Responses to Role-Taking Tasks

Source	df	MS	F
Grade	2	55.18	5.59**
Program	1	15.90	1.61
Sex	1	4.84	0.49
Grade x Program	2	1.85	0.19
Grade x Sex	1	20.15	0.50
Program x Sex	2	4.89	2.04
Grade x Program x Sex	2	34.21	3.47*
Residual	68	9.87	

* p <.05
** p <.01

The significant difference between grade levels ($\underline{F}$ (2, 68) = 5.59, $\underline{p} < .01$) is consistent with past research (e.g. Chandler and Greenspan, 1972). The origins of the significant grade x sex x program interaction ($\underline{F}$ (2,68) = 3.47, $\underline{p} < .05$) may be examined in Table 8. The mean number of egocentric responses on the role-taking tasks is greater, for example, for non-FT girls then for FT girls. A post-hoc ANOVA showed that this difference was significant ($\underline{F}$ (1, 34) = 5.56, $\underline{p} < .025$). In the case of boys, however, at grades one and two non-FT boys had slightly fewer egocentric responses then FT boys on this measure, while at grade three FT boys had fewer egocentric responses. The overall post-hoc comparison of non-FT and FT boys showed that there was not a significant difference between these groups on this measure.

Discussion

The first question raised in this study was whether the required mental operations in social role-taking tasks of this type affected the ease with which the subjects could decenter. As hypothesized, transitional subjects found it easier to decenter when they were shown the beginning of a cartoon and were asked to think how another person might think the story ended; i.e., "next" question task. This finding held across the four cartoons on which this analysis was possible. When the analysis was applied to each cartoon separately, however, only two of the four cartoons were found to provide evidence supporting the hypothesis. It is possible that decentered responses may have been suggested by the cartoons in the context in which the next questions were asked. Additional research is underway to investigate this possibility.

The second question raised in this study concerned the interrelation between the measures of classification and the measures of role-taking. These data support a conjecture offered by Miller, Kessel and Flavell (1970) that "thinking about thinking" seems to require the ability to understand the concrete operational part-whole classification structures symbolized by grouping 1 (Flavell, 1963).

Only one child at each grade level was both preoperational on the Smedslund and decentered on the role-taking measures. In addition there were several subjects who gave operational responses on the Smedslund and responded egocentrically to the role-taking task. It seems reasonable to infer, therefore, that the ability to perform the Smedslund task at an operational level is a necessary but not sufficient condition for decentered social role-taking. The pattern of the relation between the responses on the Smedslund task and the responses on the role-taking tasks, together with the small number of subjects within each grade level, yielded statistically insignificant relationships. However, these particular data are compelling in their own right, and a significant association between these responses across grade levels provides additional support for the association between the operational grouping 1 structure responses and decentered responses on the social role-taking tasks.

The social role-taking tasks used in this study seemed to require the ability to coordinate parts of a whole in a manner symbolized by the concrete operational grouping structure I. Evidence has been presented to support this relation. The multiplicative classification grouping structure III necessary for solution of tasks in the Nixon test does not seem to describe the cognitive operations required in the solution of the role-taking tasks. No relation is expected, therefore, between responses to the Nixon task and responses to the role-taking tasks within grade level, and no relation was found. The significant association between responses to the Nixon task and responses to the role-taking tasks across grade level may be accounted for by the increases in frequency of operational and decentered responses with increases in age.

The significant association between classification and role-taking abilities, using the strict criterion for operational responses on both classification tasks, can be attributed in part to the large number of subjects who were preoperational on these tasks. At grade one, for example, 72% of the subjects were preoperational on both tasks, and at grade two this figure was 46%. When the relation was considered across grade levels 50% of the subjects were preoperational on both tasks. It seems, therefore, that there is no simple relation between classification ability (on both tasks) and role-taking ability. This would support, in part, the quantitative analysis reported by Hollos and Cowan (1973) in which role-taking and classification abilities loaded on separate factors.

There was some, though not unequivocal, evidence supporting the hypothesis that the FT program subjects were superior to their non-FT controls. When a strict criterion for operational classificatory thinking was applied (operational responses on both classification tasks), the FT subjects were more advanced than the non-FT subjects. However, the difference was not statistically significant at a high level of confidence. When the tasks were analyzed separately, a similar trend was found for the Nixon test, but not for the Smedslund task.

There were no differences between FT and non-FT groups in terms of the numbers of low income children in either program nor were there differences between low and non-low income subjects on the responses to the two measures of classification. Therefore, income does not seem to contribute to the difference between FT and non-FT on the classification measures used in this study.

There also were some indications that the FT subjects were superior to the non-FT subjects on the measures of social decentration. The initial evidence for this was found in the significant sex x program x grade interaction. Inspections of the means indicated that there was a FT x grade interaction for males and females separately. That is, FT females were shown to be significantly superior to non-FT females across grade levels. Third grade non-FT females, however, were slightly less egocentric then their comparison FT peers. In the case of male subjects, the third grade FT sample had the fewest number of egocentric responses to this task in comparison to any group within grade and sex. The first and second grade FT subjects, however, had a slightly greater number of egocentric responses than their non-FT peers.

In summary, evidence was obtained to demonstrate that performance of social role-taking tasks was dependent on the type of mental operation required. Additional research is underway to discover to what extent these findings depend on the figurative content of the cartoons, and whether these results can be replicated. Secondly, the results may be interpreted as suggesting that the ability to produce an operative solution to the Smedslund task is a necessary but not sufficient condition for decentering on this type of social role-taking task. In addition there were significant associations between role-taking and classification abilities across grade levels, and at grades one and two using both classification tasks together. the pattern of these associations, however, was less compelling than in the case of the Smedslund task. Finally, the hypothesis concerning the effects of the FT program was partially supported. That is, FT females were significantly superior to non-FT females across grade levels on the measures of social role-taking; and there was a non-significant trend for all FT subjects to be superior on both the Nixon classification test and on both measures of classification together across grade levels.

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APPENDIX A

Descriptions of the Cartoons

The Giraffe Cartoon. #1

Picture 1. A boy is shown pointing to an apple in a tree, a girl is standing beside him, and a basket is sitting on the ground beside them.

Picture 2. The boy tries to help the girl climb the tree to get the apple.

Picture 3. The boy brings a ladder over to the tree where the girl is waiting.

Picture 4. The boy has climbed the ladder and is trying to reach the apple in the tree. A giraffe's head has just appeared from behind a house in the background.

Picture 5. The boy and the girl are sitting by the basket on the ground and looking sadly at the apple in the tree. The ladder is leaning against the tree.

Picture 6. The giraffe is reaching for the apple, and it looks as though she is going to eat the apple. The boy and girl look on aghast.

Picture 7. The giraffe, carrying the apple by its stem, places the apple in the basket. The boy and girl look happy.

The Snowball Cartoon. #2

Picture 1. Two small boys are standing beside a house and one of them is pointing towards a small girl carrying a shovel.

Picture 2. The two small boys are waiting behind the house and they are making snowballs. The small girl with the shovel appears to be walking into an ambush.

Picture 3. The boys wait, hidden, with their snowballs, and the girl approaches with her shovel.

Picture 4. The boys are smiling, with their snowballs held ready for throwing, and the girl is no longer visible.

Picture 5. One of the boys looks around the corner of the house, the girl is not in the picture.

Picture 6. The boys look up and see the little girl about to shovel snow down onto them from the roof of the house.

Picture 7. The boys are inundated with the snow off the roof.

The Pig Rescues Cartoon. #3

Picture 1. A pig dressed in a jacket is looking at an island through a telescope from a balloon. Some figures appear to be dancing on the island, and there is a little boat beside the island, and it appears to be sinking.

Picture 2. The pig lands on the island by pulling his balloon down towards a coconut tree with an anchor on a rope. The island is a tropical island and there are some huts amongst the trees.

Picture 3. The pig has now climbed down a rope ladder and is looking at the dancing figures while perched high up on a coconut tree. The figures are gorillas and they are dancing around another pig which they are cooking in a pot.

Picture 4. The pig from the balloon is throwing coconuts at the gorillas which are in process of running away in disarray. The pig who is in the pot looks very uncomfortable, and appears to be sweating.

Picture 5. The pig from the balloon has overturned the pot, and is standing beside the pig who has just been rescued holding its "hand" and pointing in the direction of the balloon.

Picture 6. The pigs are climbing up the ladder to the balloon and the gorillas are just appearing on the other side of the picture, looking very dismayed.

Picture 7. The pigs have escaped, and are on the left of the picture waving to the gorillas who are left standing in a group in the middle of the island.

The Pig Falls Cartoon. #4

Picture 1. The two pigs are flying over some land in the balloon. One of the pigs has leaned over the edge of the balloon too far and his hat has fallen off. Many trees are visible on the ground far below.

Picture 2. The pig who lost his hat has fallen out of the balloon, and the pig who remains in the balloon is seen reaching out of the balloon as though trying to save the falling pig.

Picture 3. The pig is seen falling head first into apparently deep snow, the hat is falling beside him, and a bear is approaching from the right of the picture.

Picture 4. Three bears are seen standing beside the little pig, who has righted himself in the deep snow, and is looking with apparent alarm at the bears.

Picture 5. In this picture one of the bears picks up the pig's hat, and the pig remains sitting in the snow.

The Pig and the Wolf Cartoon. #5

Picture 1. The pig is walking down the road in a pastoral setting.

Picture 2. It is night and the pig is walking, apparently amicably, with a wolf who is carrying an umbrella. There is a house in the background.

Picture 3. The pig and the wolf are standing by the entrance of the house. The wolf is standing graciously aside to let the pig enter the house first. The house has the appearance of being a pleasant thatched cottage.

Picture 4. The pig is seated by the fire in a comfortable looking chair and seems to be asleep. A large black pot is heating over the open fire, and the wolf is walking towards the pig.

Picture 5. The wolf has jumped towards the pig who wakes up very startled. The pig's chair has begun to fall over backwards, and the wolf's jumping has knocked over a small stool.

Picture 6. The little pig is opening the door, and wolf appears to have fallen over the small stool, though he is obviously doing his best to detain the pig.

Picture 7. The pig has opened the door, and is fleeing as fast as his legs can carry him into the night, the wolf is hidden behind the door which is wide open.

Picture 8. The pig is quite alone in the forest, running past a big tree, the wolf is nowhere in sight.

The Chandler Lost Coin Cartoon.

Picture 1. A little girl is tossing a coin while standing beside a drain in a street.

Picture 2. The coin falls into the drain to the anguish of the girl.

Picture 3. The little girl is seen looking sadly at the drain.

Picture 4. The girl is sitting on the sidewalk looking glum.

Picture 5. A little boy has arrived carrying a baseball glove.

Picture 6. The little boy beckons with his hand and the little girl begins to cry.

Picture 7. The little boy is seen with a question mark above his head to indicate that he doesn't understand why the little girl is crying.

Picture 8. The little girl is crying and the little boy wonders why she is crying.

The Chandler Melting Snowman Story.

Picture 1. A girl is seen with a large snowman standing in the sun.

Picture 2. The sun is melting the snow man.

Picture 3. The sun is melting the snowman and the girl is looking sad.

Picture 4. The girl is walking on the street looking sad.

Picture 5. The girl passes a bakery.

Picture 6. The baker indicates that he has something to show the girl who looks happy.

Picture 7. The baker places a tray of snowman cookies in the bakery window. The little girl looks alarmed.

Picture 8. The little girl is seen crying, and the baker has a question mark above his head indicating that he doesn't know why the girl is crying.

APPENDIX B

Scoring of Responses to Cartoons

1. The Giraffe Cartoon

The overall purpose in scoring was to determine whether the subject was aware that the "late arriving bystander" will not have the same perspective as the subject himself. Perspective was inferred from the subject's reasoning when the subject was asked to put himself in the other person's place; responses which include privileged information were coded egocentric.

Egocentric responses were those which stated that the giraffe would help the little boy and girl get the apple down. This was sometimes stated categorically, e.g., "The giraffe would get it"; and sometimes not so firmly, e.g., "Maybe the giraffe would help them." In each case, the response was coded egocentric.

Decentered responses were those which indicated that the subject knew that the "bystander" would not say that the giraffe would help them get the apple down. Examples: "They would climb the tree"; "They would get a bigger ladder"; "They would get their daddy to get it for them"; "They would cry."

2. The Snow-ball Cartoon

Two questions were asked after the subject told the story; they were of the forms (a) "What happened next?" and (b) "What happened before?"

The next question.

The subject was asked what would a "bystander" think was going to happen next if he saw the little boys getting ready to throw their snowballs? Egocentric responses were those which indicated that the little girl went inside and threw snow down on the boys (privileged information). Examples of egocentric responses are:

"The snow is pushed off the roof onto the two boys"; "The little girl is not there and they don't throw the snowballs"; "The girl goes into the house." Examples of decentered responses are: "The boys would throw the snowballs"; "The girl went around the back of the building." Care had to be taken on this question since the response "The boys are throwing the snowballs" might mean that is what is happening in the stimulus materials. The interview question "What would happen next?" was asked in order to assess the child's understanding of what another person would think was going to happen next. Therefore, it was sometimes necessary to ask "What happened then?", to assess whether "they are throwing the snowballs" means "they do throw them" or merely "they look as if they are about to throw them."

The before-question.

The subject was asked what a bystander would think if he saw the last picture, and only the last picture. More specifically, what would the bystander say if we said "why is the snow falling?" Egocentric responses were those which said that the little girl pushed the snow off the roof onto the boys. Some responses very like this were given which were coded as decentered; for examples, "Someone pushed the snow off the roof, but the bystander wouldn't know it was the little girl because he didn't see that picture." Other examples of decentered responses: "The snow just fell on them from the sky," "The wind blew it off the roof," "It melted and fell off the roof."

3. The pig rescues cartoon.

(a) The next-question.

Subjects were shown the picture of the pig arriving at the island in his ballon and looking at the gorillas cooking pig in a pot; the question is -- "What would the bystander think was going to happen if he was shown only these pictures?" Egocentric responses referred to what actually happened in the story, and included: "The pig would throw coconuts (sometimes thought to be rocks) at the gorillas (or monkeys) and they'd escape," "They would escape." Examples of decentered responses are: "The gorillas would eat the pig," "The gorillas would catch the pig in the tree and eat them both."

(b) The before-question.

The stimulus picture was one showing the pigs in the balloon flying away from the island. The question was what would the bystander think the pigs were doing. Egocentric responses were those which indicated that the bystander would think the pigs were escaping from the monkeys on the island. Sometimes a subject would say that the bystander would think the pigs were coming from the island. This response would leave in doubt the reason the pigs were thought to have for leaving the island; thus the question "What would the bystander think the pigs were doing there" would be asked. Decentered respones included "They were going for a ride," "He wouldn't know the pig was rescued".

4. The pig falls cartoon

(a) The next-question.

The subject was shown the first few pictures, up to the picture showing the pig falling out of the ballon. The question was "What would the bystander think was going to happen next?" Egocentric responses were those which said that the pig would fall in the snow and meet bears. Responses which merely reported falling in the snow were followed by probing to discover whether this implied decentering or not. Thus, responses which said that the pig fell in the snow "and broke his leg" were decentered, and those which said "and met bears" were coded egocentric.

(b) The before-question.

The subject was shown the pictures of the pig sitting in the snow with the bears and asked where the bystander would think the pig came from. Egocentric responses were those which indicated that the pig came from the balloon. Responses which indicated that the pig came from the sky were probed to discover whether the pig had some other mode of transport -- usually he had not. Examples of decentered responses include: "The pig came from his farm," "The pig went for a walk, fell into a hole, and the bears found him."

5. The pig and the wolf cartoon.

The next-question.

The subject was shown the pictures of the wolf about to jump on the pig who is asleep in the chair by the fire. The question was what would a bystander think was going to happen if he were to be shown these pictures. Egocentric responses were those which referred to aspects of the pigs escape: e.g., "The pig ran out the door into the forest," "The pig escaped." Decentered responses tended to terminate the pig; e.g., "The wolf would boil him and eat him," "The wolf will kill the pig."

The before-question.

The subject was shown the first and last picture in the sequence and asked what a bystander would think had happened to the pig. "Why is the little pig walking around in the forest at night?" Egocentric responses were those which referred to the wolf as a reason that the pig was out in the forest. Decentered responses were those which indicated that the pig had been doing something else: e.g., "The pig had gone to pick apples," "The pig got lost in the woods," "He saw something that scared him (not a wolf)."

Mathemagenic Activities Program
University of Georgia Follow Through
Dr. C. D. Smock, Director
April, 1974

APPENDIX C

Individual Data Forms

Name

Grade Age FT non-FT (Circle one)

Teacher

School

Smedslund task

Child answers questions 1 - 9 correctly. Yes No details...

Answers to questions:

10. Red or Square

11. How do you know that?

12. Red or Square

13. How do you know that?

Colored blocks task

Item 1.	Sorted according to criterion; On first or second sort?	yes	no	Reason Given? On which question 1,2,3
Item 2.	Sorted according to criterion; On first or second sort?	yes	no	Reason given? On which question 1,2,3
Item 3.	Sorted according to criterion; On first or second sort?	yes	no	Reason given? On which question 1,2,3
Item 4.	Sorted according to criterion; On first or second sort?	yes	no	Reason given? On which question 1,2,3
Item 5.	Sorted according to criterion; On first or second sort?	yes	no	Reason given? On which question 1,2,3
Item 6.	Sorted according to criterion; On first or second sort?	yes	no	Reason given? On which question 1,2,3

Mathemagenic Activities Program
University of Georgia Follow Through
C. D. Smock, Director
April, 1974

Name Grade

School Teacher FT Non-FT

Tape No:

Giraffe Story. If we showed____these pictures and asked how did they get the apple down, what do you think he would say? Remember he only sees these pictures.

Chandler tasks

Snow man story. What would the bystander think was happening in these pictures?
Lost coin story. What would the bystander think was happening in these pictures?

Other tasks

Snow - ball story. Next?
Before?

Pig rescues pig story. Next?
Before?

Pig fall story. Next?
Before?

Pig and wolf story. Next?
Before?

Name Grade

School Teacher FT non-FT

Tape No.

Giraffe story. If we showed____these pictures and asked how did they got the apple down, what do you think he would say? Remember he only sees these pictures.

Other tasks

Snow - ball story. Before?
Next?

Pig rescues pig story. Before?
Next?

Pig falls story. Before?
Next?

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Next?

Chandler tasks

Snow man story. What would the bystander think was happening in these pictures?
Lost coin story. What would the bystander think was happening in these pictures?

THE CONCEPTS OF APPEARANCE, DISAPPEARANCE, AND REAPPEARANCE: A DEVELOPMENTAL SEMANTIC ANALYSIS

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AUGUST, 1975

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The work that led to this paper was supported in part by the Mathemagenic Activities Program-Follow Through (C.D. Smock, Director) under Grant No. OEG-8-522478-4617 (287), HEW, Office of Education, and the Department of Psychology, University of Georgia. The opinions expressed in the paper, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

The Concepts of Appearance, Disappearance, and Reappearance:
A Developmental Semantic Analysis[1,2]

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August, 1975

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[1] The authors would like to thank Susannah and Travis Tomasello who made this study possible; Stuart Katz, John Richards, Nancy Shumaker, C. D. Smock, and R. H. Pollack for critical comments. This report is based on activities supported (in part) by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorement by the U. S. Office of Education should be inferred.

[2] Aspects of this research were reported at SRCD, 1975, under the title of Semantic and Cognitive Development, and at APA, 1975, under the title of A Conceptual Analysis of Activity Words in Early Child Language.

PREFACE

The subject of this report is longitudinal description of one child's early language development. Spoken language is of basic importance to the cognitive and social development of children and especially important for the school learning process. Language is both a medium for communication and a tool of reflective thought. A teacher's understanding of her (or his) children depends upon the ability to understand and use of the child's linguistic expressions for constructing appropriate (i.e., MAP like) opportunities for learning and cognitive growth. Further, a central feature of Piagetian theory is that to understand a child's current cognitive structures the preceding structures must be analyzed. Thus, longitudinal analysis is necessary for full understanding of intellectual development, including language.

This research may be considered "basic" or "pure" research in that application to elementary school language problems is not immediate and direct. However, we believe the conceptual analysis of language utilized here is unique and the developmental aspects of the study makes an important contribution to the understanding of language from a Piagetian perspective. In that sense, the investigation provides information that may well be a prerequisite to constructing a meaningful curriculum process for reading as well as other subject matter areas.

C. D. Smock, Director
Mathemagenic Activities Program

Every time a child speaks, he reveals something about his 'knowledge of the world'. It is not that he formulates a piece of knowledge according to the rules of the language he is about to learn; rather, he produces an expression in whatever way he can, using words as well as non-verbal means, such as intonation, gestures, facial expression. This compound message is a reflection of the way the child, at that moment in his development, organizes his experience. In this paper we shall attempt to describe one child's cognitive development as it reveals itself in a limited but important area of semantics, namely the area of the appearance, disappearance, and reappearance of experiential items. However, since the study of developmental semantics has no generally accepted assumptions, definitions, or methodology, we must be explicit, first, about what we are describing, i.e., our assumptions and definitions; and second, about how the study is carried out, i.e., our method of semantic analysis.

Lexical Meaning, Intention, and Context

What kinds of knowledge does the child express in his earliest utterances? The various linguistic approaches that focus on syntactic and/or semantic structure, as defined by transformational grammarians, tend to attribute linguistic knowledge to the child; but since the language produced by the child is characterized precisely by the fact that it does not conform to the grammar and usage of the adult speaker, it is difficult to see how a description of child language in terms of adult grammar can tell us much about why the child uses language the way he does. Our focus, therefore, will not be on "linguistic competence", but rather on the inferences we can draw, from the child's use of language, about the conceptual world he is striving to express. In a general way, this focus will be found also in Bloom (1973), Dore (1975), Edwards (1974), Nelson (1974), Antunucci and Parisi (1973), Sinclair (1970), and Wells (1974). Ceccato et al., 1960, Norman and Rumelhart 1975, Schank, 1972, 1975, and von Glasersfeld, 1963 1972, have developed similar approaches to the semantics of adult language.

Most developmental psycholinguists have described the child's meaning (semantic intention) using three basic components: the items referred to by the linguistic expression ('lexical meaning'), the purposive communicatory behaviors manifested by the child ('intention') and the immediate situational context.

Though using different approaches and terminologies, most theorists have agreed that the first two of these are a part of semantic structure. For example, Antuncci and Parisi's generative semantics model (1974) distinguishes the proposition from the performative, and Dore's speech acts analysis (1975) distinguishes the referential from the intentional. Indeed, evidence is mounting that the child has some control of the intentional component before he learns his first words (Bates 1973, Trevarthen et. al. 1975).[1]

The place of situational context in semantic structure, however, is not as well defined. Some syntactic approaches have sought to minimize its role, while some semantic approaches have emphasized the child's active use of context (deixis). In this latter category are Parisi (1974), who claims that the child constructs his semantics intention at two cognitive levels, one conceptual and one situational, and Greenfield, Smith, and Laufer (in press) who have even posited a relational meaning in one word utterances, the relation being between the semantic intention and the situational context We believe that context is an integral part of the child's meaning, but we do not believe that it can be considered a distinct and separate part. From the infant's point of view, the situational context is still far from being a wholly externalized component to be related to his conceptual structures. Rather, it is a not yet differentiated aspect of both the referential and the intentional components.

Even in the case of the adult speaker, though he may be able to separate what is called "context" from the individual items and events to which he refers in his utterance and from the intentions which he strives to realize by means of his speech act, some of his referents necessarily belong also to the situational context and some of his intentions necessarily derive from it. An utterance such as "Please open the window!" requires a window to be part of the situational context, and the intention from which the utterance springs requires that the window in fact, be "not-open"; for if it is already open, the intentional component of the utterance makes no sense.

Thus one can (and we believe, must) exploit the situational context in any interpretation of the meaning of utterances, but the very conception of a situational context being one and the same for both speaker and interpreter requires a caution. The commonality of context springs from a commonality in the construction and externalization of conceptual structures on the part of the speaker and the interpreter (receiver), and this commonality, therefore, is not a foregone conclusion, (von Glaserfeld, 1974; 1975). Among adults of a similar background it can be, and is to a large extent, taken for granted; but in the interaction with children (who, by definition, are still in the process of developing adult representations and views of the world) we can never be very sure that the items and events the child refers to are the same as the items and events which we, as adults, consider the "obvious" situational context.

In determining the lexical meaning of a child's utterances, therefore, we shall have to take great pains to consider not only the present context of the utterance but also the contexts of as many previous tokens of that utterance as possible. Since we cannot ask the small child: "What do you mean by this or that?", it is only be comparing the utterances and the situational contexts in which they are made over time, that we can glean an indication of how a particular situation is structured in the child's experience and what he is trying to express in the utterance that arises from that experience. With regard to the child's intention, our inferences will have to be based on his accompanying behaviors (again, placed in relation to his situational context) and his reaction to immediately subsequent events (e.g. is he delighted or displeased with a parent's response?) [2]

The outcome of the analysis will be a single graphic representation for each expression, incorporting aspects of lexical meaning on the one hand, and, on the other, aspects of the intentional situation from which the expression springs. These graphic schemes, in our view, reflect the Piagetian schemes characteristic of the sensory-motor and pre-operational stages of development, and these two aspects reflect the Piagetian distinction between the structural and the affective aspects of every cognitive construct.

Method of Analysis

Lexical Meaning

A variety of approaches to meaning in child language have been proposed. The best-known model of semantic development is Clark's (1970) Semantic Feature Theory, in which lexical meaning is represented in terms of dichotomous perceptual features, e.g., the child's word dog may have the distinguishing feature 'four-legged' and thus be overextended from the adult point of view. In our opinion, many of Bolinger's (1965) criticisms of a similar adult model apply to Clark's method as well (cf. also Nelson, 1974). But, more importantly, as a model of semantic development, it is unsatisfactory: First, because it uses only static features and, second, because development is viewed as an accretion of these features. We believe that the child's conceptual representations are dynamic and relational, not static and additive. As to development, we find that it must be characterized as a succession of reorganizations that change the nature and the pattern of relations both within and between 'features'. It is clear that our reservations about Clark's model stem from our different view of cognition and, consequently, of the relation between cognitive and semantic development. (cf. Baron, 1973 and Talmy, 1970 for other component approaches).

Nelson (1974), from our point of view, comes closer to what is needed, since she explicitly discriminates the cognitive from the semantic. Her 'functional core concepts' form the lexical aspect of the child's meaning and contain both perceptual-descriptive and functional-relational components. This view is more compatible with the cognitive approach of this paper, according to which even the most 'static' items in the adult's perceptual world, i.e., permanent objects, are complex sensory-motor coordinations developed as a result of active manipulations. Thus, for instance, the concept "ball" is composed of both perceptual (roundness, etc.) and functional (rolls, bounces, etc.) components, the two aspects being closely related in our view to Piaget's distinction between figurative (perceptual) and operative (functional) elements.

Simplified 'core concepts' and other discrete components of meaning (such as Nelson's) may be an adequate instrument of semantic analysis for words that designate objects. Though the child constructs the components actively, once he has constructed them, he may indeed use them recurrently as units. However, very early in his development, the child begins to refer to activities. In so doing, he treats a sequence as a unit, i.e., he treats a compound of spatial and temporal relations as a recurrent and thus nameable entity. Both Clark and Nelson suggest that their methods could be extended to include activity words, but neither specifies how this is to be done. Nelson speculates that 'movement' would be a core concept in many activity words. But we can see no way in which a listing of components, with no account of the relations between components, could capture the dynamic aspect of activity concepts.

We aware of two approaches to semantic development which attempt to describe these relations in an explicit way. They do so by using activity components (in principle not unlike Nelson's 'movement'), objects, and their relations. First, following Lindsay and Norman's model, Genter (1973) has mapped out components and their relations for some verbs of possession. Using activity components ('chunks') such as CAUSE, CHANGE, TRANSFER, and DO, she has hypothesized varying degrees of complexity for these verbs and then provided support for an order of acquisition with a cross-sectional comprehension experiment. In the diagrams she provides, spatial relations (e.g., the direction of object transfer) are indicated by arrows, and often temporal relations are indicated by use of a reference point (e.g., the time of the transfer). Although her experiment is cross-sectional and concerns comprehension, the model could in principle be applied to a child learning language. Development, in this model also, is conceived as an accretion of components.

Second, using the logical model of the generative semanticists, Antinucci and Parisi (1973, 1974) have mapped certain activity words (spontaneously produced by one child) as logical constellations which involve 'arguments' (roughly, objects), activity components, and their relations. Not unlike Genter, their analyses rely on activity components: CAUSE, CHANGE, BECOME, COINCIDE, etc. They indicate relations by specifying organized connections. The conceptual core of these representations does not itself develop, but rather its arguments are 'filled in' and certain modulations (the adverbial) are mastered.

Both of these methods of analysis are a step in the right direction. The problem is that, in analyzing activity concepts, they use other (presumably more primitive) activity concepts. To give a simplified example, Genter analyses give as: agent DO something to CAUSE the TRANSFER of an object from its source to its goal. Antinucci and Parisi analyze give as: agent CAUSE an object to BECOME COINCIDE with the recipient. We have no quarrel with the substance of these largely compatible analyses. Our problem is with the primitives. If we analyze a one-year old's use of the word give, for instance, in terms of TRANSFER or BECOME COINCIDE, we almost certainly obscure the fact that the specific conceptual relations underlying his expression are quite different from the conceptual relations that will underlie his use of the same word a year later. The child's notions of space, time, causality, and objects will have undergone considerable development during that time. For example, it is probable that the precise locations between source and goal are not part of the one-year-old's conception of a motion event, whereas later they are. The primitives are not primitive enough to allow for the description of such development, or for the subtle discriminations necessary for the comparative analysis of different languages since the specific spatial and temporal relations will remain embedded within the activity components. In short, if activities comprise objects in spatial and temporal relations, components will be inadequate to capture the development of these relations, even if the components themselves are activities.

Activities and processes necessarily take place in time. A useful analogy here is the movie film. We cannot 'see' any activity in a single frame. The change or transformation characteristic of activity requires at least two such frames (cf. Bloom, 1973: 87; Edwards, 1974: 422). Following von-Glasersfeld (1972), we can map out changing relations by using discrete sequential frames - conceived psychologically as moments of attention. There are no activity components within any frame, but rather the activity is recontructed by the observer as he connects the frames. The graphic representation is meant to correspond to the mental operations of the subject that are designated by the use of a particular expression.

For example, the change of place characteristic of verbs of motion in its most general form, would be represented:

$$\begin{array}{cc} t_1 & t_2 \\ x & x \\ loc_1 & loc_2 \end{array}$$

Put into words, an object x (assumed to be the same at t_1 and t_2) 'moves' from location 1 to location 2. The particular locations involved, and their relations, are not relevant to the simple 'change of place'. But consider the activities designated by the verbs "to go" and "to come". For both of them, in their most common uses, the two locations must be in a specific relation to something else (e.g., the notion of 'here'), since "to go", normally, designates change of place away (from 'here') and "to come" change towards ('here'). On the face of it, the diagram seems to add little or nothing to the components "movement away" and "movement towards"; but once a corpus to be analyzed contains expressions such as "This bus goes to Atlanta" and "This road goes to Atlanta", no verbally labelled components can give us as clear a picture of the two conceptual structures as can diagrams that map the smiliarities and differences in a step by step sequence. (cf. von Glasersfeld, 1972).

We should point out that the primitives we are positing for the analysis of early semantic development correspond closely to Piaget's description of sensory-motor and pre-operational schemes. By the time the acquisition of language begins, these schemes have four relatively differentiated aspects (differentiated compared to earlier stages, undifferentiated compared to later stages of development): temporal relations (sequence), spatial relations (locations in a 'group of displacements'), causal relations (psychological and physical), and objects (the perceptual invariants in these relations).

(Piaget 1954, 1963). We will rely explicitly and exclusively on these primitives to construct representations of the child's lexical meaning.

Intention

Diagrams of lexical meaning, no matter how specific they are, represent that part of an expression's semantic content that is supposed to remain the same regardless of the particular situation in which the expression is used. The intentional component, i.e. the actual reason why a speaker utters a given expression, is a different and very complicated matter. What has to be discriminated is, first of all, the general purposiveness of communication and, second, the particular relation (or set of relations) between the speaker and his environment that determines his choice of the specific utterance he makes. Wells (1974: 253), for instance, states: "The initial purposes of the child's interaction with his environment have a physiological base in the avoidance of hunger, thirst and discomfort and, more importantly, in the motivation inherent in information processing and action." And he adds: "the desire to achieve the satisfaction of social interaction.....is acquired very early in life from the infant's perceptual encounters with his environment." Though these "purposes" may well be an explanation of why the child acquires communicatory skills, they are still quite insufficient for an analysis of the intentional structure from which a specific single utterance springs. For such an analysis, we believe, it will be necessary to explicate "purpose" on the level of conceptual structures, that is to say, on the level on which it arises from "negative feedback", i.e., the discrepancy between perceptual and representational items. (cf. Powers, 1973 for a full exposition of feedback control.)[3]

For the analysis of utterances made by our child subject during the developmental period under consideration and referring to events of appearance, disappearance, and reappearance, we have introduced three generic classes of speech act: Comment, Request (or Refusal), and Question.[4] At the beginning of language acquisition they can be discriminated only on the basis of the child's non-verbal communicatory devices, e.g., tone of voice, accompanying sounds produced, facial expression, gestures, and contextual clues (cf. Menyul and Bernholtz, 1969). In our view, an important part of language development manifests itself in the growing mastery of verbal means that gradually take over the communicatory function of the early non-verbal devices. This, of course, is not to say that tone of voice, gestures, etc., disappear in adult language. Indeed, they remain part of most if not all vocal communication events, but in most cases they are reduced to a supportive role and are no longer the sole carriers of specific meanings. (In written language, of course, they are vitually eliminated.)

Since the semantic analysis we are carrying out aims at supplying a graphic representation of the conceptual structures that underlie an utterance, we must discriminate 'comment', 'request', and 'question' on the conceptual level. The traditional linguists' attempt to differentiate these classes of utterances on the basis of morphological characteristics is not wholly successful, even for adult language, because in many cases the speaker does not (and, in some natural languages, he cannot) provide a morphological marker to indicate the grammatical mood (indicative, imperative, interrogative) of his utterance. In early child langauge, where morphological markers (lexical and syntactic) are almost entirely absent, the distinction can be made only on the basis of inferences from the context and the non-verbal communicatory manifestations that accompany the utterance. Moreover, since we are aiming at an explication of the conceptual structures underlying utterances, morphological markers could be no more than indicators of unspecified differences; they could never tell us what the specific conceptual differences are

Comment, request, and question, must therefore be differentiated on the conceptual level by considering the kind of intention that prompts the given utterance. In the adult use of language, the interplay of intentions between speaker and receiver is so subtle and complex that we could not hope to capture and explicate much of it with the very preliminary and simple tools we have at the moment. For the first utterances of a child, however, even the introduction of two types of communicatory intention allows us to posit a helpful classification of conceptual structures. Elsewhere we have argued that the term "communication" should be reserved to designate non-mechanical interactions between organisms where the sender's production of a signal is directed towards the goal of modifying the receiver's behavior (von Glasersfeld, 1974). The conceptual classification of child utterances which we are here proposing is directly derived from that definition of communication.

We classify as 'comment' any utterance that neither contains nor is accompanied by an indication that the child is striving to modify his perceptual input by enlisting the activity of another organism (i.e., the receiver). In regard to a child's comments, therefore, we are in agreement with Sinclair (personal communication, July 1975): comments do not originate from a need or desire to communicate. They may be explained as 'egocentric language' (Piaget, 1962) and as a symptom of the child's 'symbolic activities' (Piaget, (1962,1967) expanding from his private symbolism to the linguistic symbol system of the social community in which he happens to grow up. The conceptual structure from which a child's comment springs, therefore, will not contain the representation of a goal towards which he desires to modity his perceptual input.

In the simple situation, for instance, where an animate object (AO) (in our corpus, human or dog) at one moment is within the perceptual field

(p) of the child and at the next moment is no longer perceivable, the child's utterance *Bye* will be classified as comment, and the conceptual situation will be mapped as follows:

$$\begin{array}{llll} t_1 & t_2 & & \\ p\text{: } AO & p\text{: } \overline{A\Theta} & \underline{\text{Bye}} & \text{(comment)} \end{array}$$

(Note: Throughout this paper we use capital initials in quoted words that are contained in the corpus.)

The fact that comments do not indicate a *goal* representation does not mean that the conceptual situations from which they spring may not contain a representation at all. The early utterance, *No*, for instance, arises as a comment when the representation of an item is called forth by a percept which, owing to prior experience, is associated with that item, but the item itself is not within the perceptual field at the moment (in Piagetian terms, the 'evocation of an absent object'). Thus, the sight of the child's bottle may call forth the representation (r) of fruit juice as an expectation which then, if the bottle happens to be empty and there is no juice to be perceived, results in a discrepancy and evokes the utterance *No*. Since the source of the representation, i.e., whether it originates from association with a perceived object or from a parent's remark, at no time affects the choice of utterance at the level of development we are concerned with, we do not specify this source in the diagram.

$$\begin{array}{llll} t_1 & t_2 & & \\ r\text{: } X & p\text{: } \overline{X} & \underline{\text{No}} & \text{(comment)} \end{array}$$

The difference between 'comment' and 'request' is that the second *necessarily* involves a representation and that this representation is not merely called forth by some sort of association but also has the character of a desideratum, i.e., a state of affairs or an event which the subject would like to realize as actual experience on the perceptual level. (For the adult, there are, of course, states of affairs and events that must be realized on a purely conceptual level.) Within the corpus considered in this study, 'representation + desire' (rd), with one exception (see (c) below), involves perceptual input of the type we normally call 'objects' or 'activities'. For instance:

a) t_1 t_2 t_3

p: X p: $\overline{X}$ rd: X More (request)

b) r: X p: $\overline{X}$ rd: X name of item (request)

where in (a) an item X is perceptually present, then disappears, and its perceptual presence is desired; whereas in (b) the representation of item x is called forth by some association, the item is not perceptually present, and the item is desired.

The conceptual structure underlying a 'refusal' (negative request) differs from (a) and (b) in that it contains a negative desideratum rather than a positive one. For instance if an activity (A) is suggested to the child, verbally or by other means, the suggestion calls forth a representation of the activity, but what is desired is, in fact, the negation of that representation:

t_1 t_2

c) r: A rd: $\overline{A}$ No (request)

Finally, the conceptual structure underlying a 'question' is similar to the 'request' structures, except that the desideratum, in this case, is not the item itself but an indication as to its location. In this sense, the questions contained in the corpus are the only cases of 'request' that can be satisfied by a response from the receiver that does not directly modify the subject's perceptual experience of physical objects and activities. The receiver's response can, in fact, be a verbal answer. The desideratum, in this case, is not an item to be perceptually experienced but rather information concerning the item's location.

Data

Collection

The data on which this paper is based are part of a larger corpus collected by the first author and his wife in a diary study of their daughter's language development. Two kinds of record were made. First, a diary was kept in which all utterances (except direct imitaitons, stereotypic 'routines', and repeated examples of the same utterance in the same context) were recorded togther with their situational contexts. After the appearance of several types of two word expressions (16 months), the same criteria were appled except that from then on object words used as single word utterances were no longer recorded. All new words, all changes in the use of old words, and all combinations (whatever their composition) were recorded. At monthly intervals, the parents would review the dairy entries for each non-object word and add any information they deemed useful (especially further contextual data and information about frequencies). A 'meaning' was assigned to each word at each monthly interval for future reference.

Second, at these same monthly intervals (within a few days), video and audio recordings were made. Four video sessions (at 16, 17, 18, 19 months) were conducted at the University of Georgia Psychology Department with child, parents, and some toys. Three audio sessions (at 17, 18, 19 months) were conducted at home with father and child.

Selection

The total corpus is composed of words which our subject (Travis) used referring to: 1) objects, 2) properties, 3) her own activities (e.g., *hit*, *bite*, *swing*, etc.), 4) the activities of objects (their movements and locations both within, and into and out of, the perceptual field), and 5) 'events' in which her own activities and the objects involved form an undifferentiated unit (e.g., *phone* and *rocking-chair* referring either to the object or the activity associated with it). While types 1 and 2 are relatively straightforward, types 3, 4, and 5, containing specific activities, are a classification based on Piaget's distinction between physical and psychological causality.

The development described in this paper takes place within the fourth category, i.e., concepts involving the behavior of objects *relatively* independent of the subject's activity. Within this category, there are words referring to the movements of objects (e.g., *move*, *go*, *come-here*, etc.); the location of objects (e.g., *up-here*, *down*, *over-there*, etc.); and the appearance, disapperance, and reappearance of objects. It is this last group with which we are concerned here.

In most of the current child language taxonomies these groups have been referred to as 'existence', 'non-existence', and 'recurrence'. Some authors have even grouped them under a single heading (e.g., Brown, 1973, calls them 'operators of reference' and Bloom, 1975, calls them 'functional relations'). We substitute the terms 'appearance', disappearance', and 'reappearance' because we feel they are more appropriate descriptions of the child's experience. It is not surprising that these categories are prevalent in the literature as a 'major meaning' of early child language, since all objects in the child's experience continualily appear, disappear, and reappear. In fact these very activities are crucial to the child's attribution of 'permanence' to the invariant in these events.

The data reported here begin with T's first references to the disappearance of objects (approximately 14 months) and proceeds to a point where she has 17 different lexical items referring to the categories under study (approximately 20 months). Table 1 provides an overall picture of T's semantic development and of our analyses in this are. The data from which the table is derived are presented in summary form, for each lexical item at each period of development, in the appendix. Note that since the naming of objects was not systematically recorded, it is not included in this analysis. If it were, it would come under the headings of comment and request for appearance.

Table 1 **Analysis and Chronology of Expressions**

	1 (pre 15)	2 (15–16)	3 (16–17)	4 (17–18)	5 (18–19)	6 (post 19)
APPEARANCE Comment	p:$\overline{AO}$ p:AO Hi - - -	- - - - - - - - - - - - - - - -	expands to - - - - p:$\overline{O}$ p:O	- - - - - - - - reverts to r:O p:$\overline{O}$ p:$A(\overline{O}\rightarrow O)$ Find-it -	p:$\overline{AO}$ p:AO - r:X p:$\overline{X}$ p:$CA(\overline{X}\rightarrow X)$ Make - - p:$\overline{M}$ p:M On - - -	- - - - - - - - - - Hi - - - - - - - - - Find-it - - - - - - - - - - Make - - - - - - - - - - On
Request	r:O p:$\overline{O}$ rd:O Where's -	- - taken over by<	rd:O p:$\overline{O}$ rd:$A(\overline{O}\rightarrow O)$ Find-it rd:O p:$\overline{O}$ rd:Loc.O Where's	- - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - rd:X p:$\overline{X}$ rd:$CA(\overline{X}\rightarrow X)$ Make - p:$\overline{M}$ rd:M On - -	- - - - - - - - - - Find-it - - - - - - - - - Make - - - - - - - - - On p:$\overline{A}$ rd:A - - - - Do-it
Question			rd:O p:$\overline{O}$ rd:Loc.O Where's	- - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - -	- - - - - - - - - - Where's
RECURRENCE Comment				p:X p:$\overline{X}$ p:X More - -	- - - - - - - - - - - - - - - -	- - - - - - - - - - More p:CO p:$\overline{CO}$ p:CO - - Another
Request	p:O p:$\overline{O}$ rd:O Where's -	- - - - - - - - - - - - - - - - p:F p:$\overline{F}$ rd:F More - -	- - -taken over by - - -expands to - - - - - - p:A p:$\overline{A}$ rd:A Again -	p:X p:$\overline{X}$ rd:X -	- -	- - - - - - - - - - More - - - - - - - - - - Again p:CO p:$\overline{CO}$ rd:CO Another
DISAPPEARANCE Comment	p:O p:$\overline{O}$ Where's - p:AO p:$\overline{AO}$ Bye - - -	- - taken over by - - expands to - - - - > p:O p:$\overline{O}$ Gone - - r:O p:$\overline{O}$ r:X p:$\overline{X}$ No - - -	p:X p:$\overline{X}$ -taken over by	- -	reverts to - - - p:AO p:$\overline{AO}$ - - - - - - - - - - - - - - - - p:F p:$\overline{F}$ All-gone p:M p:$\overline{M}$ Off - -	- - - - - - - - - - - Bye - - - - - - - - - - Gone - - - - - - - - - - - All-gone - - - - - - - - - - Off p:A p:$\overline{A}$ - - - - Finished p:TV p:$\overline{TV}$ - - - - Over
Request		p:X rd:$\overline{X}$ No - - -	- - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - p:A rd:$\overline{A}$ Stop-it	- p:M rd:$\overline{M}$ Off - -	- - - - - - - - - - No - - - - - - - - - - Stop-it - - - - - - - - - - Off

Explanation of Code Used in Table 1

Each linear cluster of code letters, consisting of two or three adjacent groups, describes the hypothesized conceptual structure that underlies the verbal expression on its right. To save space, the indications t_1, t_2, t_3, designating the sequential 'frames' of the structure, have been eliminated. Each group of letters, separated from the next by a blank space, characterizes one 'frame' of the sequential structure.

Lower case letters followed by a colon indicate the conceptual status of the items (capitals) in that frame.

p: = percept;
r: = representation;
rd: = representation + desire.

Capitals are abbreviations of the types of item involved in the conceptual structures.

A = activity;
CA = creative activity (resulting in the appearance of new perceptual item);
I = item of any type;
O = any object;
AO = animate object;
CO = countable object;
F = food;
M = mechanical item that creates change in environment;
TV = television program
Loc. O = location of item.

A small horizontal line directly above a capital letter indicates the non-presence (negation) of the item designated by the letter.

A bracket following A (activity) indicates the change brought about by/or expected from the activity; e.g., $A(\bar{0}\to 0)$ indicates that the activity results in 0 becoming perceptually present.

An intermittent horizontal line to the right of a verbal expression indicates that the expression continues to be used throughout the subsequent period. Changes in its use are explicitly indicated.

Discussion

Conceptual Distinctions

The conceptual distinctions we make to account for Travis' semantic development fall into four general categories:

1) Distinctions of intention;
2) Distinctions of the sequential order of perceptual or representational items;
3) Distinctions of the mode of appearance;
4) Distinctions of the perceptual items involved in the sequence.

1) Travis is able to express desire by varying her intonational pattern and by the use of other communicatory behaviors that accompany the verbal utterance (gesturing, etc.). This was observed first in naming and in the early occurrences of Where's, both of which were used either as comments or as requests. Then there is the emergence of questions, as shown by Travis' addressing the utterance Where's to a person rather than to objects, and more importantly, by the fact that information (usually, but not always, verbal) satisfied her, where before only the indicated object was acceptable. There is probably close interplay between this development and the child's developing means of effectively utilizing locational information; i.e., there may well have been an intermediate stage where locational information was acceptable only if it quickly led to obtaining the object in question (this hypothesis, however, cannot be confirmed from our data). In the case of the utterance No, the intonational difference between its use as request and its use as comment was also quite obvious. Here the request is negative (rejection or refusal), and this is marked in the diagrams by the negated object in the representation of the desideratum.

2) The second category involves distinctions in the sequential order of percepts and representations. The primary distinction is whether perceptual presence precedes non-presence (disappearance) or vice versa (appearamce). Thus the early use of Where's as comment and Bye as comment are differentiated from naming as comment and Hi as comment. Although requests for appearance could initially be differentiated from requests for reappearance only on the basis of the observed situational context (Where's was used as request during the first period, both in contexts of appearance and reappearance), as soon as Travis learned the new expression More, and used it exclusively for the experiential sequence 'presence, non-presence, desired presence', we could be sure that she conceptually differentiated this sequence from the sequence 'representation, non-presence, desired presence'. This could be considered the developmentally earliest discrimination of representation and perception that is marked by the differential use of verbal expressions. (Note that a desired representation is distinguished prior to this from a 'neutral' representation, by non-verbal means, wheras here we are dealing with distinctions within one intentional mode, i.e., the request mode.)

Another distinction that falls within this category is the following. At 15 to 16 months, No as comment is distinguished from Where's and Bye, as comment, by the first step in the sequence. In the case of No, it is a representation (expectation) rather than a perceptual item. Gone initially refers to both of these situations and ultimately becomes the only expression for them, so that by the end of this development the distinction is no longer expressed. But since Travis did originally make the distinction, and since a similar distinction is maintained in other areas, we can assume that in this case it simply lost its usefulness.

3) The third category involves distinctions as to how an item appears. Specifically whether or not it is an activity (of Travis herself or of others)

that results in the appearance of an item. Both Find-it and Make, when used as requests, are distinguished by the child's expectation that an activity carried out by the addressee will lead to the perceptual presence of the desired item. When used as comments, they are accompanied by the child's own activity, locomotive for the first, and stationary (stirring in a bowl, changing the position of objects, etc.) for the second.

(Note: We are avoiding the term "cause" because we do not want to imply that any of these verbal expressions indicate awareness of causality in general or as a conceptual principle. On the other hand, we have no doubt that a child, at the stage of development with which we are concerned, is constantly acquiring new action schemes that are based on regularities of practical experience. Cf. Piaget, 1974:8. Morever, since this corpus contains only two expressions explicitly involving causal concepts, we do not have enough data to examine this area).

4) Unlike the three above categories, which have to do with the structure of the sequence, the last one has to do with the nature of the items involved in the various steps. The first distinction in this regard is between Where's and the single names of objects, when used as requests. While Where's was used with objects only (animate and inanimate), the use of names showed no restriction and it served also to request activities. Next, use of Hi and Bye, except for a period of generalization, was restricted to animate objects. The utterance All-gone, on the other hand, originated and was consistently used for edible objects only. Further distinctions within this category concerned mechanical items (On and Off), a television program (Over), the temporary restriction of More to food and drink, and countable objects (Another). An important and wholly consistent distinction was also made by using Again, Stop-it, Do-it, and Finished exclusively for activities.[5] Finally, creative activity is distinguished from other activities on the basis of the situational context in which Make is used. We can, of course,

not be certain that Travis conceptually discriminates creative activity from activities involved in searching and finding, but her consistently appropriate use of the two utterances in different contexts implies it (moreover, there seems to be some evidence for this discrimination in areas of the corpus not included in this study). Note that differentiation of the item involved in a sequence only takes place after a general term for that sequence has been established - i.e., we do not observe a host of specific terms (for food, animate objects, activities, etc.) followed by a more general term. Rather, we observe a global term initially assimilating many situations which are later differentiated.

Development

One basic assumption of our study is that the formation of conceptual structures (e.g., 'permanent objects') must have taken place before verbal expressions can be semantically linked with such structures (e.g., 'naming').[6] Therefore we have to discriminate two types of development. On the one hand, there is the development of the child's conceptual world and, on the other, the development of his means to express that world. From the observer's point of view, these two processes of development cannot be separated absolutely. If "learning a new verbal expression" means not only acquiring the ability to produce that expression physically (i.e., to utter it), but also to produce it appropriately (i.e., to use it in the 'right' situational and intentional contexts), then both the conceptual and the semantic development are necessary conditions for this learning, but neither of them is by itself sufficient (cf. Bloom, et. al., 1974, for corroboration of this point).

The interrelation of the two developments is by no means a simple one. To explicate the way in which we have analyzed our data, it will be indispensable to state as clearly as possible how we see this interrelation between conceptual and semantic development.

Before the child can establish a semantic nexus (permanent association) between two experiential items (e.g., the visual-tactual percept 'dog' and the auditory percept of the word *dog*), both these items have to have reached a relative 'permanence' in the childs conceptual world. That is to say, they must have recurred often enough in the child's experience for him to have registered sufficient similarities between individual instances, so that he can 'recognize' a subsequent occurence of them as a new instance of the same item. At that moment, the child is in a position to associate the two experiential items, which now, since they have achieved a relative stability and repeatability, we may call 'conceptual structures' or 'concepts'. But - and this is the point we want to stress - what the child associates are *his* conceptual structures, and because they have been constructed exclusively on the basis of *his* experience, they may be significantly different from the structures of the adult speaker of the language. Thus the child may assimilate an experiential item, which the adult calls *sheep* or *cow*, to the conceptual structure he has linked to the word *dog*. The adult observer will then speak of an 'overgeneralization' or 'overextension' of the word. For example, T originally used *More* for foods only, but later extended its use to all types of items (even to activities in situations where *Again* would have been closer to adult usage). In such cases, the question whether the child's lack of specificity is due to a lack of conceptual differentiation (i.e., he does not *perceive* the difference) or a lack of semantic differentiation (i.e., he does not have a means to *express* the difference) would have to be answered by behavioral experimentation (e.g., discrimination tasks) or on the basis of evidence from other semantic areas. Presumably, he will eventually accomodate his usage to conform with his linguistic community.

While some expressions in the child's vocabulary extend their scope during early development, other expressions show an inverse pattern, i.e., they become more specific. The most obvious example in our corpus is Where's which was initially a global expression used in three situations: as a comment on disappearance, and as a request either for the appearance or the reappearance of an object. Its comment funtion is taken over fairly early by Bye, which is temporarily generalized; as request for reappearance it is taken over by More, as that generalizes. The appearance request splits into two expressions: one a request for information (question), the other a request for an activity leading to the object's appearance (expressed by Find-it). In these cases, given our assumptions about semantic development, we can attribute both conceptual and semantic discriminations to the child.

These dual processes, we believe, constitute the basic pattern of semantic development. As cognitive development proceeds (i.e., conceptual distinctions and reorganizations), some of the expressions which the child initially uses globally, become more specific in that their range of application is reduced which, in some cases, is the result of partial substitution by other expressions. On the other hand, terms that originate with a certain specificity may become less specific because of extension, or retain their specificity, in which case new conceptual distinctions may be indicated by other expressions. These patterns highlight the weakness of viewing semantic development as accretion. The development of conceptual structures and means of expression is manifestly an interactive one. Sometimes a new conceptual structure is expressed in a new way, sometimes an old expression extends to cover it, and sometimes it may not be expressible at all. Each development therefore reorganizes the specific relations between the child's conceptual and semantic structures.[7]

Limitations of the Study

Some of the distinctions we have made in the uses of expressions, and the conceptual structures posited as underlying them, could have been supported (and additional distinctions could perhaps have been made) if, after the appearance of each new espression, experimental manipulations of the situtaional contexts had been performed. For example, *Where's* and the use of names (both as requests) at 15 months could have been tested by removing perceptually present objects, by reminding Travis of an absent object (verbally or by means of an associated item), and by moving an object to a place where it would have been inaccessible but still perceptible for her. Likewise, the distinction between *Bye* and *Gone* could have been made clearer in a few instances by a deliberate disappearance maneuver or verbal reminder and varying her expectation of reappearance (verbally or by repetition of the sequence). Also, the range of items to which some expressions were applied could have been established more precisely by experimentation, particularly in the cases where the range extended or narrowed over time (e.g., *More* and *Again* could have been pitted against each other in situations of recurring activities). Needless to say, this pre-supposes that expressions could have been elicited by means of a parent's deliberate manipulation of perceptual items - and that is certainly not a foregone conclusion in all situations. Nevertheless we feel that valuable and perhaps crucial evidence could have been gathered in that way, if data collection and analysis had been carried out concurrently.

We should like to emphasize also that the analyses presented in this paper must be considered approximate and provisional until we have analyzed the whole corpus. There may well be distinctions that will turn out to be spurious or misrepresented when related expressions in the remainder of the corpus are taken into account; and there may also be distinctions that we should have, but didn't make. In the as yet unanalyzed part of our data there are expressions referring to movement away (*Go*, *Leave*, etc.), expressions referring to movement towards the subject (*Get-it*, *Come-here*, *Bring*, etc.), and expressions referring to a combination of movement and reinstatement (e.g., Back). That these expressions are related to 'appearance', 'disappearance', and 'reappearance' is obvious. It is very possible that, when all these other expressions have been analyzed and their specific relations to the subset we have considered here can be made explicit, some particulars in this preliminary exposition may have to be adjusted. Note especially that, while we could have used 'location' (spatial relations) in the analysis (e.g., by referring to 'location within perceptual field', 'location outside perceptual filed'), we did not introduce it, because it was not needed to differentiate the expressions in this corpus. This 'primitive' will bovIously be crucial to out analysis of other activity words (e.g., expressions referring to movement of objects).

Since our corpus contains the verbal production of only one child, we should not speculate about the generality of our findings. The composition of our corpus seems to be, on the whole, rather similar to other data in the literature. Yet, a precise comparison is difficult owing to the widely diverging points of view of the compilers. The one set of data with which we feel justified in comparing our corpus is Bloom's diary study (1973) of the one-word stage. She reports the following distinctions:

1) intentional differences (comment as opposed to request) are noted for Away, No, Again, and More;
2) 'existence' (There, uh-oh) is distinguished from 'non-existence' (Away, No, Stop, All gone) and from 'recurrence' (Again, More);
3) differences concerning the items involved: Stop for activities; All-gone, originally used for food and then generalized; Again and More, though sharing some uses, the second is the more general expression.

Table 2 shows a direct comparison of a composite of Bloom's data (the relevant one-word expressions listed by her for the period from 10 to 16 months) and ours.

Table 2
Comparison with Bloom's Data (1973)

	Existence (Appearance)		Non-existence (Disappearance)		Recurrence (Reappearance)	
	Bloom	T.&. v.G.	Bloom	T.&. v.G.	Bloom	T.& v.G.
Comment	*There* *Uh-oh*	*Hi* *Find-it* *Make* *On*	*Away* *No* *All gone* *Stop*	*Where's* *No* *All-gone* *Finished* *Bye* *Gone* *Off* *Over*	*Again* *More*	*More* *Another*
Request		*Where's* *Find-it* *Make* *On* *Do-it*	*Away* *No*	*Off* *No* *Stop-it*	*Again* *More*	*Again* *More* *Where's* *Another*

One final limitation should be mentioned. In this corpus we observe practically no indication of 'syntactic structures'. This is undoubtedly due to the nature of the expressions we have chosen for this analysis; they are equivalent to Bloom's (1973: 20-24) 'function forms'. They are expressions which by themselves designate a relation, and thus the meaning of the two or three word strings in which they occur is primarily determined by them. These words tend to occur in similar contexts and in similar semantic roles regardless of the other words they are combined with. Our semantic analysis, therefore, does not reflect a major means of expression, i.e., the use of a lexical item for different semantic functions (agent, patient, etc.).

Conclusion

The overall aim of this investigation (and related ones that are under way or planned) is to design and perfect a method for the study of pre-operational cognitive development. Most work focused on this period has tended to define pre-operational structures by their deficiencies relative to concrete operational thought. We believe that a detailed semantic analysis of verbal expressions and their development over time, utilizing both naturalistic and experimental methods, is a promising path towards an understanding of the child's conceptual structures and will accentuate the positive aspects of cognitive development during this very important early period.

Nelson (1974: 274), in reviewing the difficulties of applying Piagetian theory to language development, states: "Although Piaget (1962) has devoted considerable thought to the character of preconcepts (pre-operational schemes) and their reflection in the language of the young child, there is as yet no link established between the specific action scheme or the preconcept and the general categories of thought (space, time, and causality) that develop in infancy." (parenthetical explications ours)

Many theorists have paid lip service to Piaget's sensory-motor schemes as the roots of semantic knowledge, but, to our knowledge, no one has attempted the kind of detailed analysis that would yield the specificity necessary to establish precise relationships between semantic and cognitive development.

We have analyzed only one semantic area, for one child and one language. Much more will have to be done before the results presented here could be considered adequate. But we believe that our method of determining and mapping sequences of conceptual construction, by considering non-verbal manifestations, situational contexts, and, above all, developmental changes in the use of the verbal expressions themselves, can provide insights that will go a long way towards determining these relationships.

The present study quite obviously is only one first step in that direction. Yet, the analysis of expressions such as Make and Find-it, for instance, has already provided some clues about the beginning conceptualization of causality. When the whole corpus is analyzed, we hope to have a more complete picture.[8]

Finally, a methodological point: Nelson (1974: 279) suggests an analytical approach to semantic development, but as she says: "Unfortunately, most of the language diary studies....do not permit the kind of analysis needed to determine the basis for original word meanings and their shift over time."

If this is true of the diary studies, it is all the more true of studies using periodic cata collection. We have attempted to capitalize on the advantages of both means of data collection (the richness of a diary and the precision of tapes) so that the kind of analysis Nelson proposes can be performed. We should mention that an analysis of just our tape data would look very scanty and that diary data alone would have left open some questions which we were able to answer by referring to the tapes (especially the video tapes, where context can be more easily reconstructed). In our study it was also possible also to expolit the cumulative background knowledge and observations of the parents in a way that few studies have done. We do not believe that investigators of child language can turn on a tape recorder for a few hours every few weeks and obtain data that will reflect developmental processes. Nor do we believe that developmental semantic analysis can utilize formal linguistic models that were not designed to reflect the mental operations of a language user. If we are interested in the child's cognitive structures and how he expresses them in language, then we must observe a child's day to day development in the full range of his environmental situations and analyze the data in a way which at least attempts to represent the thought of the child.

Footnotes

[1] The subject of our study in fact was naming a few objects and using non-verbal means of communication (whining, gesturing, etc.) for a parallel period of a few days before she made the connection that naming could augment her other communicatory behaviors.

[2] Since all of these factors (past usage, intentional behaviors, and present context) can only be determined by taking into account the child's experiential history, we stress the role of parent interpretation (as other have, e.g., Parisi 1974). Consequently, we view as an important asset the fact that one of this study's investigators is also a parent of the subject.

[3] In Piagetian terms, when an attempt to assimilate a perceptual experience to existing structures leads to a disequilibrium, attempts to accomodate these structures have the "purpose" of eliminating the disequilibrium.

[4] Our division therefore is in agreement with the notion of a performative (e.g., Antunucci and Parisi, 1974, distinguish 'requestive' from 'descriptive') and it is identical with Bloom's (1973) 'comments' and 'requests' (since questions are viewed as a special type of request).

[5] The appearance of expressions reserved exclusively for actively situations is important because it demonstrates the development of activity concepts towards stable structures which can serve as components of larger structures.

[6] It does, of course, happen that we pick up a word (or syntactic construction) for which we do not yet possess a conceptual structure. In these cases we subsequently 'acquire' its meaning by inference from the situational and linguistic contexts in which others use the word (or from a dictionary). This often takes quite a long time during which we may have

all sorts of misconceptions about the meaning of the expression.

[7] Note expecially in our data that as Where's narrows to use as a question to use as a question, its other functions are taken over in two cases by the extension of an established expression (Bye and More) and in a third case by a new one (Find-it).

[8] One example that we have looked at briefly is Move, which Travis originally addressed to an obstructing object, then to herself as she pushed an object aside, and later to a person presumably able to remove the obstacle.

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Appendix

Letter-number combinations in the left margin (A1, R2, etc.) refer to the semantic category and to a specific period of development. Thus each distinct combination refers to a "cell" in Table 1. Each expression is listed for each period it is in active use, followed by its intentional class (comment, request, question) and comments on the situational contexts in which it occurs. (The source of specific examples, whether diary, video, or audio is omitted for the sake of brevity.)

Period preceding 15 months

A1 Appearance

Hi	comm.	animate object appearing in T's perceptual field.
Where's ...	requ.	any item T is reminded of and wants. (Always in combination with name of object.) The expression was learned (around 13 months) by imitating her parents' frequent "Where's the bottle?" But when T began to utter it spontaneously, her intonation was either demanding (here and under R1) or neutral (see D1, comment). E.g., spoon reminds her of bowl, ball reminds her of dog, or parent verbally reminds her of object.

R1 Reappearance

Where's ...	requ.	same as in A1, with same intonation. The difference is that this expression follows an item's disapppearance from T's perceptual field (hence: 'reappearance'). Since a verbal answer giving the location of the desired object would not satisfy T, whereas producing the object did, and since the utterance was not directed towards a person, we consider that neither this nor A1 above should be interpreted as a 'question'.

D1 Disappearance

Where's ...	comm.	any item disappearing from T's perceptual field. (Similar to an adult's "there it goes".)
Bye(-bye)	comm.	animate object disappearing from T's perceptual field.

Period from 15 to 16 months

A2 Appearance

Hi	comm.	no change from preceding period.
Where's ...	requ.	

R2 Reappearance

Where's ...	requ.	no change from preceding period.
More	requ.	when T has finished a food or drink and desires more. The duration between initial consumption and request is highly variable (infrequently, a general food request).

D2 Disappearance

Where's ...	comm.	taken over by Bye (near end of period).
Bye	comm.	no change from preceding period (expands near end).
No	comm.	when T expects to find an item, but does not. The expression was learned in a game of "button-button" to indicate surprise that the hidden object was not in the hand to which she pointed. Then generalized to items not being where she expects them (esp. when parent tells her to check and see if object is in her room, on shelf, etc.) Also when expected activity does not materialize (e.g., dog refuses biscuit).
Gone	comm.	first learned as answer to parents "where's ..." questions; next as a response to food having disappeared (nodesire for more); then, when T herself makes an object disappear (e.g., pouring water from bottle, eating a bite of imaginary food, etc.); infrequently, when reminded of but doesn't perceive object.
No	requ.	negative request (rejection or refusal) indicating unwillingness to accept food, put on clothes, brush hair, or to do what she is asked to do. (Also as a 'play-punishment' to herself for doing something forbidden.)

Period from 16 to 17 months

A3 Appearance

Hi	comm.	extended to variety of objects, e.g., airplane, sand, pictures in book, etc. (See Bye, D3, for similar extension.) Beginning to be combined.
Where's ...	quest.	now used as question only, directed to person and no longer generically to object or situational context; information about location satisfies the question. (If she still cannot obtain the object, she tells parent to Find-it: see next entry.)

Find-it	requ.	replaces request use of Where's ... Used when T asks where something is and parent says he/she doesn't know; or when she looks for something, cannot find it, and ask parent to look for it.

R3 Reappearance

Where's ...	requ.	taken over by More (near end of period).
More	requ.	no change initially, but extends near end of period.
Again	requ.	to request repetition of activity, e.g., tickling, making a noise, playing various games.

D3 Disappearance

Bye	comm.	frequently combined with name of object (first sentences after Where's ...) and used in a wide variety of disappearance situations, e.g., her leaving objects or their leaving her (passing of airplane, her passing under traffic light, etc.), closing book on picture, throwing object away, TV scene fades or ends, or when some sound is over (song, thunder, etc.).
Gone	comm.	less frequent (overlap with Bye; see discussion), but still used when object disappears, e.g., when T examines gingerbread man after having eaten his hand (hand...gone) and when sand ball dissolves in water (ball...gone), and when T is looking for something she has been reminded of in place where it usually is, but does not find it.
No	requ.	(refusal) no change from preceding period.
No	comm.	no change in usage, but less frequent since it is being taken over by Gone (see D3 and D4).

Period from 17 to 18 months

A4 Appearance

Hi	comm.	beginning to revert to animate objects only.
Find-it	requ.	no change from preceding period.
" "	comm.	used in combination with name of object accompanying T's own activity of search, e.g., looking through a book for a picture, looking for ducks that are usually on a pond, etc.
Where's ...	quest.	no change from preceding period.

R4 Reappearance

More	requ.	used as before except for a wider range of items, e.g., jumping, blowing out matches (i.e., activities). A few combinations. (See next entry for comment)
More	comm.	when giving mother another bite of food, seeing another fish, seeing postman deliver mail, washing more dirt from her hands, etc. (Some combinations)
Again	requ.	no change from preceding period. (Some combinations)

D4 Disappearance

Bye	comm.	no change from preceding period.
Gone	comm.	no change from preceding period. Take-over of No as comment complete. Becoming more frequent and beginning to be combined.
No	requ.	no change from preceding period. (Has dropped out as comment. See entry above.)
Stop-it	requ.	(negative request) to tell someone to cease what they are doing to her, e.g., brushing her hair, wiping her face, tickling.

Period from 18 to 19 months

A5 Appearance

Hi	comm.	no change from preceding period.
Find-it	comm.	
" "	requ.	
Make	comm.	to comment on 'creative activity', e.g., making dinner, making noise, making paper doll (activity performed by T or other). (Some combinations)
"	requ.	to request 'creative activity', e.g., blowing bubbles, drawing pictures, making noise, etc.
On	comm. requ.	commenting on, or requesting, 'on'-state of TV, music, lights, heater, etc. (opposite of Off; see D5).
Where's ...	quest.	no change from preceding period.

R5 Reappearance

More	comm. requ.	still used as before, but now more frequently and also for 'additional quantity' as well as 'additional instance', e.g., when pouring more sand onto a pile, spooning more soap bubbles onto cluster, asking for additional syrup, asking for additional hand cream.

AN ANALYSIS OF ERROR CHOICES ON THE RAVEN'S COLOURED PROGRESSIVE MATRICES

by

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May 1977

Prepared for the
MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH
of the
University of Georgia
Charles D. Smock, Director

This report is based on activities supported in part by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

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PS 011512

PREFACE

Follow Through is a federally funded research and development program designed to determine the effect of planned variations of educational experiences (different types of classroom "models") on the learning process in young children. It is a "comprehensive" educational program concerned with all aspects of community and child development, but with special emphasis on the school learning environment and parent involvement. Variations in the classroom process and curriculum have been the primary dimensions along which sponsor models differ and on which the evaluation programs have focused. The "outcomes" that have received the most attention are of course academic skills as measured by standardized achievement tests. It is clear, however, that personal, social and cognitive developmental factors are also differentially affected by variation in teacher strategy and curriculum. The MAP model is designed to promote general intellectual and social developmental factors and it is the effects of the program on these dimensions of child growth that have concerned us in many of our studies.

The measurement of the fundamental dimensions of cognitive development is as yet a subject to considerable methodological difficulties. The development of the Goldschmid-Bentler tests and the Purdue Piagetian Conservation task film has facilitated data collection on many of these factors. However, the need for new models and new measurement procedures for cognitive skills is obviously necessary.

This study is concerned with the analysis of error scores on the Raven's Progressive Matrices; a test which has a long history of utility in the measurement of general intelligence as well as selected aspects of "mental disfunction". As indicated later in this paper however, a fundamental difficulty with the test is the lack of theoretically determined multiple choice items that would reflect different aspects of the mental operations of the child during problem solution. It is becoming increasingly obvious that objective instruments for the measurement of cognitive operational skills require more than an analysis of correct/incorrect responses. Just as in the conservation tasks administered by the "method clinique", our objective indicator instruments require systematic development of multiple choice responses in order to analyze the _process_ by which the individual achieves the answer and not simply whether the answer is correct or incorrect. For this reason, the study presented here represents a significant step forward in the development of a methodology for development of an easily administered test of cognitive operational structures across age groups. Such theoretically based analyses appear most promising for the development of more fruitful measures of intellectual growth.

C. D. Smock
May 1977

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Introduction

To many educators and psychologists, mental tests play the same role relative to intelligence as a scale does for a chemist relative to a particular compound, i.e., "how much of it is there?" The assumption is that mental development is marked by increasing "amounts" of intelligence as indicated by increasingly efficient processing of information obtained from the social environment. A different assumption is made by modern developmental cognitive theorists. Piaget, for example, emphasizes the structure of knowledge and thinking processes, the participation of the organism in constructing knowledge about the environment, and the invariant sequence of stages in the development of knowledge.

The more traditional psychometric investigators believe their tests to be of significant assessment value, especially in predicting academic achievement. Often, the ability to predict subsequent achievement seems to be considered an end in itself; school systems and teachers are particularly interested in these "assessment tools." However, there is increasing evidence that Piagetian measures also have substantial predictive value for achievement level (Kaufman, 1971, Kaufman and Kaufman, 1972). Moreover, Piagetian researchers maintain that tests derived from cognitive developmental theory reveal something about the "ways" a child organizes information about the "world." For a Piagetian, it is the *organization* of knowledge that is most important for planning educational programs for children.

One of the fundamental concepts in Piaget's cognitive developmental theory is the idea that the child's mental activity becomes formed or structured through a twofold interaction with the surrounding world. First, the child has to accommodate existing cognitive structures to novel situations through change or merging of prior formed mental structures. In order for an infant to obtain the goal of jostling a glittering object hung over a crib, for example, a generalized undirected movement of the body may be sufficient. These early and primative reflexes are not sufficient, however, to provide goal attainment in more complex situations; e.g., to make the noise repetitive over many occasions. Coordination of the hand and eye reflexes requires modification of both through a process of integration of the respective structures; i.e., accommodation.

At any given stage, structures also may generalize across different situations; that is, complex environment situation can be adapted to by assimilation to existing structures. For example, a block may be used as a "hammer" to pound pegs in a board.

Analysis of intellectual ability from the Piagetian theoretical position requires, then, detailed observations of the sequences of operation in problem solution. That is, the mere correctness or incorrectness of a response to a test item, or a total score, is not sufficient for determining the effeciency of the underlying cognitive structures and processes.

The Raven's Coloured Progressive Matrices (RCPM) was developed as a test of nonverbal intellectual ability but has many features that make it a test consistent with the Piagetian theory intelligence. It was designed to measure the child's ability to complete simple continuous patterns and to reason by concrete and/or abstract analogies. The test may be administered to groups or to an individual and the subject's answers may be recorded by the subject or by an observer. Multiple choices for each item are presented with the total score providing an index of level of intellectual performance.

More detailed information on a child's performance than is reflected in the total score is possible through three refinements of the scoring system. First, the individual test situation may be modified whereby the examiner asks "why" a particular response was made-- the open-ended "justification" responses are analyzed to gain more information about the reasoning process involved. Second, a form-board version of the test is available which is administered individually and each manipulation of the blocks is recorded. Such manipulations are assumed to reflect the thought sequence of the child as he progresses to matrix solutions. Third, Raven devoted considerable effort to the design of the multiple choices for each item in order to make possible the analysis of error choices. Specifically, "types" of errors were delineated which have been used to "diagnose" certain "mental dysfunctions" inferred from predispositions toward certain types of errors. Raven's typology of errors is unsatisfactory to many researchers, however, because of the lack of a clear theoretical framework. Sigel (1963), takes the position that, rather than consider errors as reflecting "mental dysfunctions," the analysis of errors "provides us with increased specificity of the quality and the level of intellectual performance not possible from a consideration of correct responses only" (pp. 39-56).

A point of departure for error analysis from a Piagetian perspective is the dual (logical versus figurative) nature of cognitive processes. Piaget (1964) suggests that perceptual symmetry plays an important part in solving these matrix problems. "This perceptual factor is so important that it facilitates, and even produces solutions which appear to be operational but which are based on the method of 'graphic collections'" (pp. 39-56).

The purpose of this report is to present a typology of error choices based on the operative-figurative distinction and to determine the internal reliability and generalizability of scores derived from that analysis.

Review of Relevant Literature

The RCPM is a simpler version of the Standard Progressive Matrices by Raven which included sixty problems (Burke, 1958). Like the earlier and more difficult Standard Matrices, the RCPM contains a series of problems which are arranged in increasing order of difficulty. Each puzzle consists of a pattern of figures which contains an empty space and a series of alternative choices which might complete the matrix puzzle. Each choice in the booklet form is numbered and the subject must circle his or her choice on the answer sheet provided. The thirty-six problems in the RCPM are grouped into three subsections of twelve puzzles each (Set A, Set AB, and Set B). The individual child's score is usually based on the total number correct.

Raven suggests the RCPM be used with normal children form six to eleven years old, for retarded or mentally defective children or adults, and for the aged. The latter group is included because the ability to reason by analogy, according to Raven (1949), "appears to be one of the earliest abilities to decline in later life" (pp. 4). It is clear that Raven is especially interested in the reasoning by analogy puzzles (Set B) and considers the ability to solve them an important benchmark in intellectual development. Raven does not consider the RCPM alone to be a test of general intelligence but suggests it be used along with a test of verbal ability to measure a child's intellectual level. However, the RCPM is considered independent of acquired knowledge or previously developed verbal skills.

Considerable research is available directed toward answering the question: "what is the nature of the abilities measured by the RCPM?" Most of the research evidence tends to support the idea that the RCPM is a powerful measure of "g" or general intelligence (MacArthur, 1960; Freyburg, 1966; Tuddenham, 1958; Martin and Wiecher, 1954; Stacey and Carleton, 1955; Green and Ewert, 1955) and that it reflects minimum educational and cultural loadings (MacArthur, 1960).

In constructing the RCPM, Raven (1949) outlined a series of developmental changes which he contends the RCPM measures:

> A child is first able to distinguish identical figures from different figures, and later, similar from dissimilar figures.
> Some time after this he is able to appreciate a figure's orientation with respect to himself and other objects in the perceptual field.
> Later, he is able to apprehend two or more discrete figures as forming a whole, or organized individual entity.
> Subsequently, he is able to analyze the perceived whole into its constituent elements, or "characters," and distinguish between what is given and what he himself contributes.
> Finally, he can compare changes in the characters perceived, and adopt this as a logical method of reasoning.

More specifically, he constructed Set A as a measure of "The Apprehension of Identity and Change in Continuous Patterns;" Set AB as "The Apprehension of Discrete Figures as Spatially Related Wholes;" and finally, Set B as "The Apprehension of Analogous Changes in Spatially and Logically Related Figures" (1949). The detailed aspects of these processes is presented in Table 1.

Table 1: Specification of the Processes Underlying each of the RCPM Problems*

Set A Items:	Nature of the problem to be solves:	
1	Simple, continuous pattern-completion involving the perception of . . .	
2		
3		
4		
5		
6		
7		
8		
9	Completion of a pattern showing progressive changes	In one direction with perception of . . .
10		
11		In two directions with perception of . . .
12		

Set Ab Items:	
1	Discrete pattern-completion involving the perception of . . .
2	
3	
4	Discrete pattern-completion involving the apprehension of the three figures as a related "whole" to be completed by a fourth part, together with the perception of . . .
5	
6	
7	
8	
9	
10	
11	
12	

Set B Items:	
1	Discrete pattern-completion with the apprehension of . . .
2	
3	The apprehension of three figures as a whole to be completed with the perception of . . .
4	
5	
6	"Concrete" or coherent reasoning by analogy to spatial . . .
7	
8	
9	
10	Discrete or abstract reasoning by analogy to the logical . . .
11	
12	

*Taken from Guide to Using the Coloured Progressive Matrices, J. C. Raven, London: 1949, Appendix

Recent studies have used factor (or cluster) analysis of items to identify independent dimensions contributing to the total RCPM score. Corman and Budoff (1974) administered the RCPM to 243 normal subjects. Each item response was coded 1 (correct) or 2 (incorrect) and were then subjected to a principal components analysis with a varimax rotation. Four major factors were obtained and labeled as follows: (1) Continuity and reconstruction of simple and complex structures, (2) Discrete pattern completion, (3) Reasoning by analogy, and (4) Simple continuous pattern completion.

The items loading high on each factor are presented below:

Table 2: RCPM Item Loading Pattern on Four Factors*

Factor I			Factor II		Factor III		Factor IV
Continuity and Reconstruction of Simple and Complex Structures			Discrete Pattern Completion		Reasoning by Analogy		Simple Continuous Pattern Completion
A7	AB4	B3	AB1	B1	AB12	B8	A1
A8	AB5	B4	AB2	B2		B9	A2
A9	AB6	B5	AB3			B10	A3
A10	AB7	B6				B11	A4
A11	AB8	B7				B12	A5
A12	AB9						A6

*Criterion for high loading was .4 for each item (Corman and Budoff, 1974, p. 411).

Using another approach to an item level analysis, Carlson (1973), attempted to link scores on selected groupings of RCPM items to the Piagetian distinction between operational and graphic problem solving. A sample of 33 subjects were administered the Inhelder-Piaget Standard Matrix Test and subsequently assigned to one of two groups- operational (N = 11) or graphic collections group (N = 22). The RCPM was then administered to the total group (N = 33).

Statistically significant between group differences were noted on both the total score and on Set B subset score. Carlson also found that Raven's item groupings for "the apprehension of discrete figures as a whole" and "concrete or cohorent reasoning by analogy to spatial . . ." significantly differentiated between the groups. However, items 10, 11, and 12 of Set B did not significantly differentiate between the groups. Carlson (1973) concludes that different parts of the RCPM tap different processes; i.e., that sets "A and AB . . . rely on solution by graphic processes, whereas Set B involves solution by operational means" (pp.211-215)

Statement of the Problem

In the Guide to the Coloured Progressive Matrices, Raven (1949) proposed five major types of choices: (1) difference, (2) inadequate individuation, (3) repetition of the pattern, (4) incomplete correlation, and (5) correct choice. Correct choices are evenly distributed across possible positions in the multiple choice field in order to equalize positional errors.

Raven describes the role of an analysis of errors as follows:

> As the Coloured Matrices scale is designed to assess as accurately as possible a person's present clarity of observation and level of intellectual development, his erroneous responses cannot be satisfactorily used for the quantitative assessment of intellectual dysfunction. They only indicate where a person is failing, and possibly, why (Raven, 1949, p.1).

In other words, various error scores can be computed for each type of error and compared with change levels. These error scores can then be analyzed with the view of isolating and diagnosing certain mental dysfunctions.

As indicated earlier, Sigel proposed (1963) that analysis of errors can help isolate specific modes of intellectual functioning some of which are not "dysfunctional." He focused on two RCPM puzzles (A7 and B7) and found sex differences in error choice (a la Raven). The error choices of female subjects appeared related to difficulty in perceptual discrimination as reflected in response to item A7. Item B7 did not produce differences in "types" of errors made (both sexes tend to make equal amounts of "repetition of figure") but the boys and girls did differ in the specific position chosen. Sigel suggests that boys tend to perseverate vertically whereas girls tend to perseverate along the horizontal dimension.

Thus, Sigel's study is suggestive that analysis of RCPM errors have excellent potential for deriving information about aspects of cognitive functioning. Such an analysis, however, must be constrained by a specific theoretical framework; otherwise, the information can have only limited usefulness. Raven's system of error types, for this reason, does not provide much insight into the specifics of cognitive functioning. If it is found that a child makes a significant number of "incomplete correlate" errors, it is difficult to relate this to other cognitive processes or to development of cognitive operations generally. Piaget's theory, on the other hand, poses specific questions that may be answered via error analysis on matrix type problems. For example, is there a tendency to approach problem solutions on the basis of "graphic collections" rather than logical classifications." Or, might it not be possible to assess, via error analysis, the probability of transition from one stage of cognitive development to the next? Or, would not errors on puzzles of the multiplicative classification type reflect a predisposition to adopt a pre-operational perceptual strategy at one stage and an operational logical-deductive method at the next?

Before turning to an alternative way of viewing error choices guided by such questions, a number of observations about the physical layout of a typical RCPM puzzle need to be made.

A RCPM puzzle consists of two parts. The top portion, which is a box with a section missing as if it had been cut out, can be labeled the question area. The lower portion, which consists of six choices each of which could physically fit into the missing space above, will be called the answer area. The correct solution to the puzzle can be ascertained without having the possible answers present. That is, the RCPM could be administered by instructing the child to take a set of colored pencils and draw in the missing piece. From this point of view, the multiple choice nature of the RCPM has only to do with the method of communicating the answer. Using a logical strategy, the child could place his hand over the answer area, "figure out" the answer by determining the nature of the question and the logic underlying it (by logic is meant the "rule" guiding the puzzle's make-up), and finally, uncover the answers and search until it is found.

Among the possible "rules" which can be discerned in the RCPM, perhaps the most important are the so-called multiplicative classification rules. The optimum strategy to solve multiplicative classification matrices consists of simultaneously processing two or more dimensions to achieve the appropriate "class." Piaget devotes an entire chapter in Early Growth of Logic in the Child to these types of matrices and their implications for cognitive theory. At one point, he states that the RCPM is an "outstanding contribution to the field of multiplicative classification" (Inhelder and Piaget, 1964, p. 281).

A second possible strategy is a "one-by-one" trial of each choice in the empty space (by visual imagination) with a trial and error elimination of incorrect choices. In this latter case, a logical understanding or coordination of the multiple dimensions would not occur and, rather, perceptual ability would be sufficient for solution.

All matrices consist of multi-valued dimensions, such as size, color, shape, or other more complicated features like number of stripes or dots, which permit either "logical" or figurative solution. Piaget maintains that, "this perceptual factor is so important that it facilitates, and even produces solutions which appear to be operational but which are based on the method of 'graphic collection.' It is very difficult to separate operational and perceptual factors . . ." (Inhelder and Piaget, 1964, p. 153). The role of symmetry in the perceptual strategy will be considered essential as far as this analysis is concerned.

To review, the cognitive operational or logical strategy involves rule-finding and attention to the question area, whereas the perceptual strategy involves imagining, and attention to only one dimension at a time, and a special focus on symmetrical features of the puzzle. The two strategies should not, however, be considered as mutually exclusive. A child may well have both strategies available in his or her repetoire and would, perhaps, try more than one on each puzzle. However, a tendency should emerge over a number of puzzles to adopt one strategy over the other. That is, the two strategies or solutions should be separable-- "although there is a continuous transition from graphic structures to operational structures in the multiplication of classes . . . there is also a relative discontinuity as between two types of solutions, both of which lead to correct results. One is based on mere perceptual symmetries, the other on a true understanding of the relationship involved" (Inhelder and Piaget, 1964, p. 165).

The rational analysis below will proceed in two parts: (1) a logical scoring system will be constructed with the view of ranking each error choice as to its degree of logical correctness, and (2) a perceptual scoring system will be constructed with the view of ranking each error choice as to its degree of perceptual correctness.

The logical scheme is based on the assumption that utilization of a logical multiplicative classification strategy requires the subject to coordinate two (or more) dimensions at one time. The perceptual scoring scheme is based on the idea that the subject is able to utilize only one dimension at a time (the row or column dimension, whatever it might be) and that sequential associations and figural symmetry plays particularly salient roles.

Method

Subjects

Subjects were selected from a group of six to eleven year olds in grades one to four involved in the Follow Through program. The Raven's Coloured Progressive Matrices was administered in the Spring of 1975 as a part of the MAP Multiple Outcome Study (Silverman and Smock, The instructions for this administration are presented in Appendix A. Biographical characteristics of the children are presented below in Table 3.

Table 3: Biographical Characteristics of Children in the Multiple Outcome Study

		Grade 1	Grade 2	Grade 3	Grade 4	Total
		%	%	%	%	%
sex	males	47.9	45.7	39.5	51.2	46.0
	females	52.1	54.3	60.5	48.8	54.0
race	white	64.8	65.2	63.0	53.7	61.7
	black	35.2	34.8	37.0	46.3	38.3
income	low	52.1	53.3	49.4	54.9	52.5
	non-low	47.9	46.7	50.6	45.1	47.5
program	FT	53.5	56.5	63.0	68.3	60.4
	NFT	46.5	43.5	37.0	31.7	39.6
mean age (in years)		6.78	7.91	8.82	9.86	8.38
numbers Ss		71	92	81	82	326

Preliminary Factor Analysis

The RCPM problems selected to be included in the rational analysis were AB12, B7, B8, B9, B10, B11, and B12. The choice of these problems was based on a factor analysis in which these items loaded most highly on a common factor labeled "matrix multiplication." This pattern of factors, and loading (see Appendix B) were similar to that reported by Corman and Budoff (1974).

Rational Analysis

Part 1: Logical Scoring System:

Presented with the following matrix:

N/M	W/M
N/S	?

the correct solution may be found by a logical strategy (i.e., coordination of informational elements):

(1) left side of the slash (first dimension) - read left column top to bottom, and then the right top to bottom or N is to N, as W is to what,

(2) right of slash (second dimension) - top row left to right and then the bottom row -- M is to M, as S is to what.

The correct answer is W/S.

The possible alternative choices can be assessed as to the degree of "fit" to the correct answer by the extent of the match to the horizontal and/or vertical dimension.

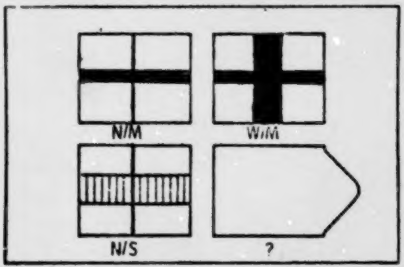
For example, a choice such as W/M would be correct in the first dimension (left of the slash) and incorrect in the second dimension and assigned a value 1. The answer M/M would obtain a score of 0 since neither the first nor second dimension is correct.

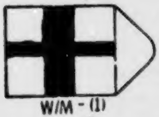
Each of the matrix problems were analyzed according to the system presented above. Accompanying each figure, for both the question and answer area, is the symbolization for each informational element. The score for each choice appears in parentheses. An asterisk marks the dimension in the answer area which is irrelevant information.

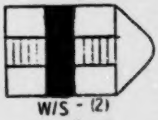
Puzzle AB12:

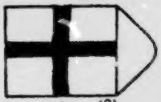
Vertical (left of slash): N = narrow line and W = wide line.

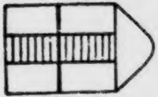
Horizontal (right of slash): M = medium line and S = striped lines.

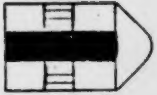


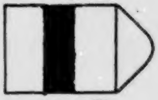
1

W/M - (1)

2

W/S - (2)

3

M/M - (0)

4

N/S - (1)

5

S/W - (0)

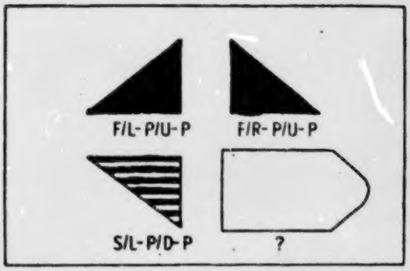
6

W/* -(1)

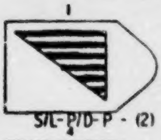
Puzzle B7:

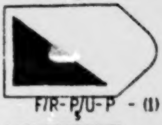
Vertical: L-P = left-pointed and R-P = left pointed triangle.

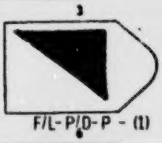
Horizontal: F = filled (or solid) and L = lined (or striped).

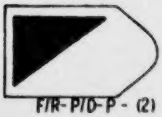
Horizontal: U-P = up-pointed and D-P = down-pointed triangle.

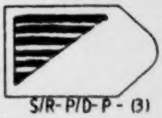


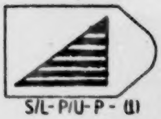
1

S/L-P/D-P - (2)

2

F/R-P/U-P - (1)

3

F/L-P/D-P - (1)

4

F/R-P/D-P - (2)

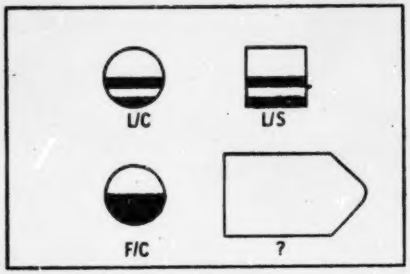
5

S/R-P/D-P - (3)

6

S/L-P/U-P - (1)

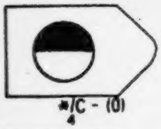
Puzzle B8

Vertical: C = circle and S = square.

Horizontal: L = lined and F = filled (note that only the lower half of each figure is to be considered).

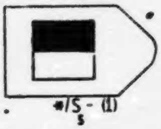


1



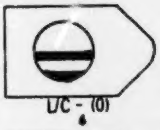
*/C - (0)

2



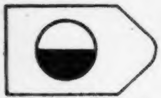
*/S - (1)

3



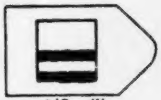
L/C - (0)

4



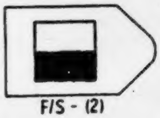
F/C - (1)

5



L/S - (1)

6

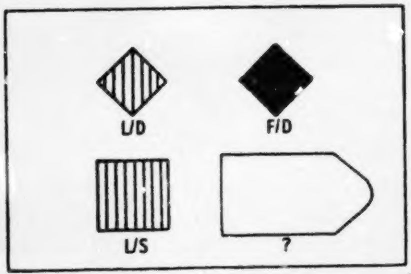


F/S - (2)

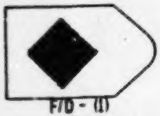
Puzzle B9

Vertical: _ = lined and F = filled.

Horizontal: D = diamond and S = square (note that in position 6 the lines are not allowed since they are wrongly oriented).

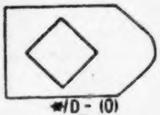


1



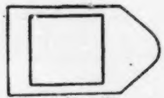
F/D - (1)

2



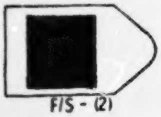
*/D - (0)

3



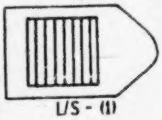
*/S - (1)

4



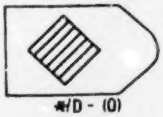
F/S - (2)

5



L/S - (1)

6

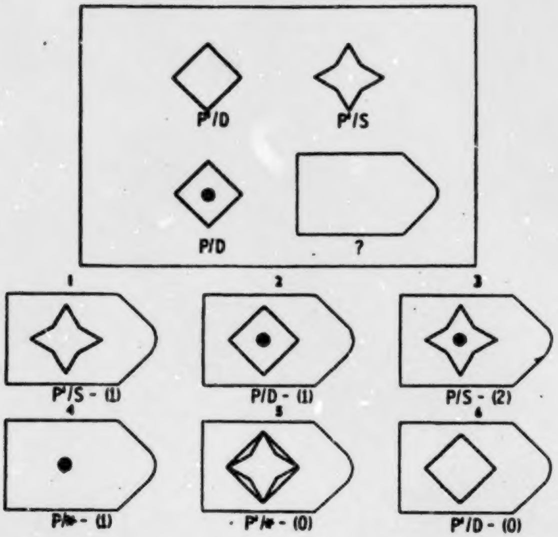


*/D - (0)

Puzzle B10

Vertical: D = diamond and S = star.

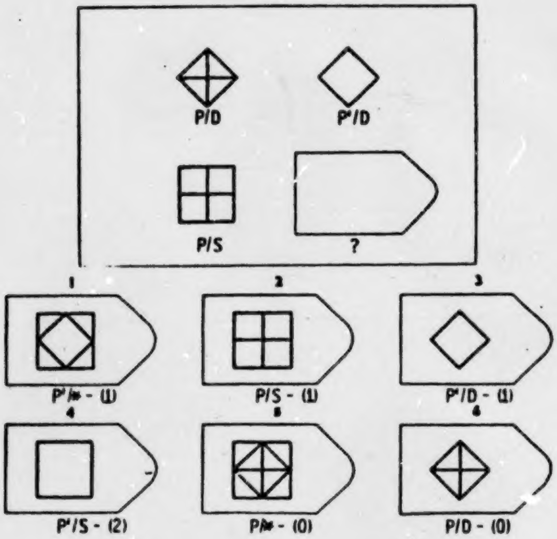
Horizontal: P = period and P' = not period (negation).


P'/D
P'/S
P/D
?
1
2
3
P'/S - (1)
P/D - (1)
P/S - (2)
4
5
6
P/ø - (1)
P'/ø - (0)
P'/D - (0)

Puzzle B11

Vertical: P = plus sign (cross) and P' = not plus sign.

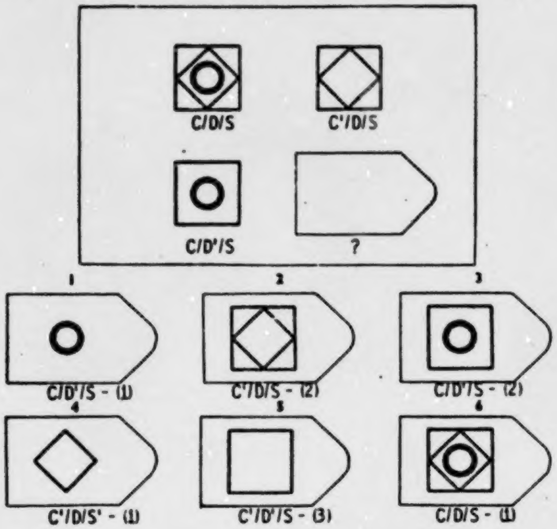
Horizontal: D = diamond and S = square. (Note that horizontally the relevant dimension is shape and that an answer area position which contains more than one shape is considered incorrect.)


P/D
P'/D
P/S
?
1
2
3
P'/ø - (1)
P/S - (1)
P'/D - (1)
4
5
6
P'/S - (2)
P/ø - (0)
P/D - (0)

Puzzle B12

Vertical: C = circle and C' = not circle.

Horizontal: D = diamond and D' = not diamond. Both vertically and horizontally, S = square and S' = not square.



A summary of these scores is presented on page 26 following.

Part 2: Perceptual Scoring System

The rationale for the perceptual scores is based on problem solutions that utilize symmetry and one-dimensionality of the available informational configuration. Symmetry usually involved adjacent puzzle pieces and often repetition of figures. However, the repetition of figure may not involve symmetry. For example, note the following.

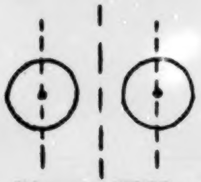


Figure VIIIa:
repetition of figure
with symmetry

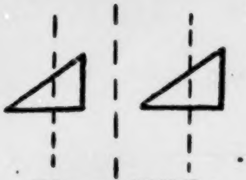


Figure VIIIb:
repetition of figure
with no symmetry

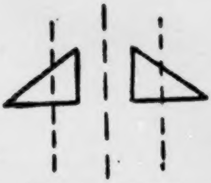


Figure VIIIc:
non-repetition of figure
with symmetry

Notice that both figures VIIIa and VIIIb are examples of "repetition of figure" but only Figure VIIIa is, strictly speaking, symmetrical. The reason for this is that each individual piece in Figure VIIIa is itself "internally" symmetrical if it is cut through by an axis. But the triangles are not and must be rotated (Figure VIIIb) to obtain symmetry. Therefore, "repetition of figure" will be considered the more potent perceptual factor as compared to symmetry, although symmetry may be presented in some examples of repetition of figure. For example, imagine two repetition of figure positions of Puzzle AB12 placed in the empty question area quadrant as follows.

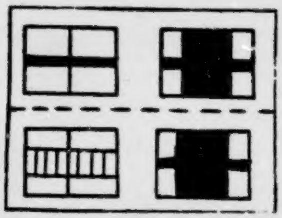


Figure IXa: Puzzle AB12 with repetition of upper-right piece (position 1)

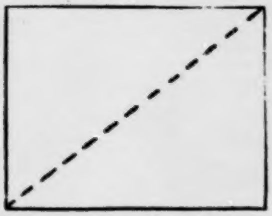


Figure IXb: Puzzle AB12 with repetition of upper-left piece (not present)

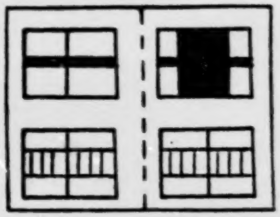


Figure IXc: Puzzle AB12 with repetition of lower-left piece (position 4)

We can see (Figure IXa) that if the horizontal dimension (medium line/striped line) is ignored, the vertical elements (narrow line/wide) of the question area are symmetrical. But, Figure IXc presents the opposite case. If vertical dimension (Figure IXc) is not considered, then the horizontal dimension is symmetrical with respect to the entire question area. These are the situations which involve global symmetries. One point, therefore, is assigned to choice of position 1 and 4 for repetition of figure and a second point to each for their respective global symmetries.

Puzzle B7

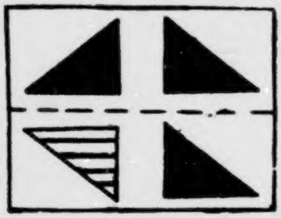


Figure Xa: Puzzle B7
with repetition of
upper-right piece
(position 2)

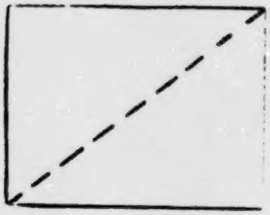


Figure Xb: Puzzle B7
with repetition of
upper-left piece
(not present)

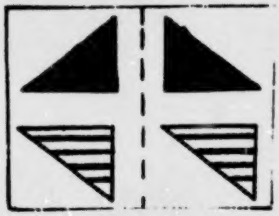


Figure Xc: Puzzle B7
with repetition of
lower-left piece
(position 1)

According to the scoring procedures, choices in position 2 and 1 exhibit repetition of figure and a score of one (1) is assigned. The pieces in Figure Xa are symmetrical (balanced) with respect to the dark solid/striped dimension, and thus a second point is assigned to this choice. The choices as shown in Figure Xc involve an imprecise symmetry with regard to the up-pointing/down-pointing dimension, but receives a second point as well.

Puzzle B8

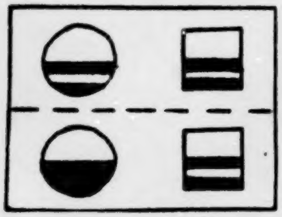


Figure XIa: Puzzle B8
with repetition of
upper-right piece
(position 5)

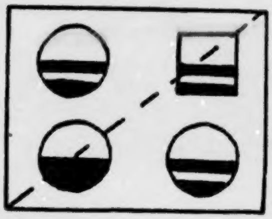


Figure XIb: Puzzle B8
with repetition of
upper-left piece
(position 3)

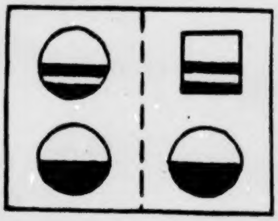


Figure XIc: Puzzle B8
with repetition of
lower-left piece
(position 4)

Positions 4, 3, and 5 are assigned a point each because they are a repetition of figure. Position 4 gets an additional point for a global balance with regard to the striped/filled-in dimension; and position 5 gets an additional point for a global shape symmetry.

Puzzle B9

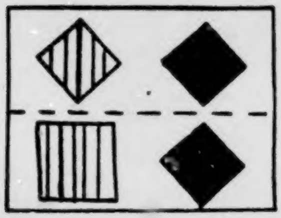


Figure XIIa: Puzzle B9 with repetition of upper-right piece (position 1)

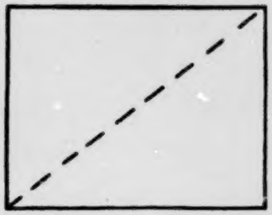


Figure XIIb: Puzzle B9 with repetition of upper-left piece (not present)

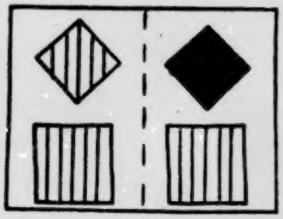


Figure XIIc: Puzzle B9 with repetition of lower-left piece (position 5)

Both positions 1 and 5 show repetition of figure. Position 1 in addition shows striped/filled-in dimension symmetry and position 5 shows shape dimension symmetry.

Puzzle B10

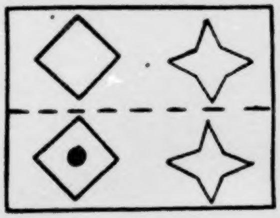


Figure XIIIa: puzzle B10 with repetition of upper-right piece (position 1)

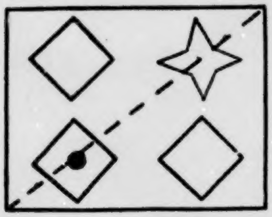


Figure XIIIb: Puzzle B10 with repetition of upper-left piece (position 6)

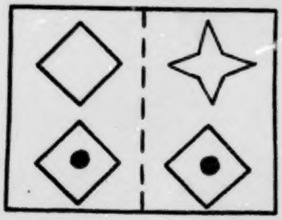


Figure XIIIc: Puzzle B10 with repetition of lower-left piece (position 2)

Positions 2, 6, and 1 show repetition of figure. Position 1 also shows shape dimension symmetry, while position 2 shows dot/dotless dimension symmetry.

Puzzle B11

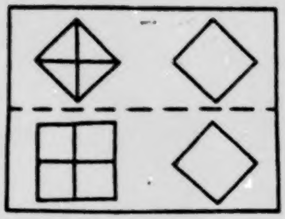


Figure XIVa: Puzzle B11 with repetition of upper-right piece (position 3)

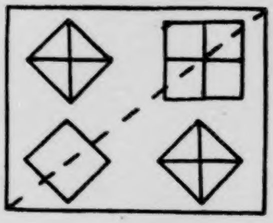


Figure XIVb: Puzzle B11 with repetition of upper-left piece (position 6)

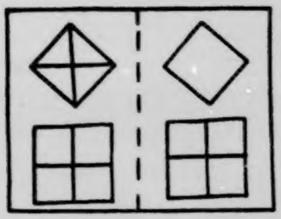


Figure XIVc: Puzzle B11 with repetition of lower-left piece (position 2)

Positions 2, 6, and 3 exhibit repetition of figure. Position 2 also shows shape dimension symmetry, whereas position 3 shows plus-sign/not-plus-sign dimension symmetry.

Puzzle B12

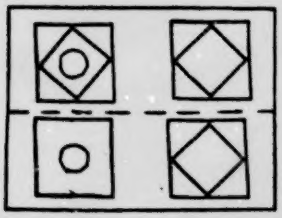


Figure XVa: Puzzle B12 with repetition of upper-right piece (position 2)

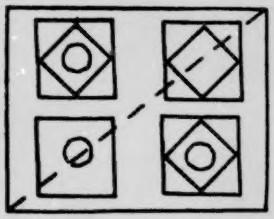


Figure XVb: Puzzle B12 with repetition of upper-left piece (position 6)

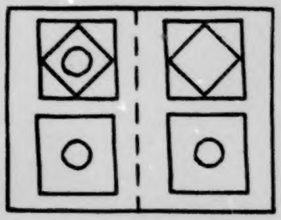


Figure XVc: Puzzle B12 with repetition of lower-left piece (position 3)

Positions 3,6, and 2 show repetition of figure, however, both positions 3 and 2 show shape dimension symmetry. In Figure VIIIb the upper left diamond must be ignored to give perfect symmetry relative to the entire question area, while in Figure VIIIb the upper left inner circle must be ignored to perserve perfect symmetry.

The logical and perceptual scores assigned to each choice of the problem matrices used in this study are summarized in Table 4.

Table 4

Summary of the Logical and Perceptual Scores for Each RCPM Problem

Choice - Position	AB12	B7	B8	B9	B10	B11	B12
1	1/2	2/2	0/0	1/2	1/2	1/0	1/0
2	2/0	1/2	1/0	0/0	1/2	1/2	2/2
3	0/0	1/0	0/1	1/0	2/0	1/2	2/2
4	1/2	2/0	1/2	2/0	1/0	2/0	1/0
5	0/0	3/0	1/2	1/2	0/0	0/0	3/0
6	1/0	1/0	2/0	0/0	0/1	0/1	1/1

Results

The reliability and validity of the rationally derived scoring system constitutes the primary purpose of this study. Statistical analyses were completed to provide evidence relevant to the following:

1) Internal reliability of the modified RCPM scale made up of seven matrices subjected to the rational analysis.
2) The correlation between age and each of the derived scores; i.e., logical and perceptual.

As mentioned before, the RCPM was only one in a set of tests given the subjects. Among the other tests were the Matching Familar Figures (MFF) test and the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP). Both are picture matching tasks developed to measure the child's impulsivity-reflectivity tendencies in a situation where he or she is to choose, from six pictures, the one which matches a "standard" picture. An analysis was completed to determine:

3) The relationships between this independent measure of **decision time** and the perceptual scores (predictive of a negative γ) and the logical scores (predictive of a positive γ).

Finally, the scores determined by the rational procedures will be correlated with another measure of logico-operational thought to obtain an independent assessment of the validity (construct) of the rationally derived scores. Specifically, Piagetian theory assumes the ability to conserve substance, length, weight, etc., to be the result of a decentering "so as to transform transitory relationships into a coherent system of objective, permanent relations" (Piaget, 1967). Therefore:

4) **Measures of the conservation concepts will correlate positively with the logical scores and negatively with the perceptual scores.**

The logical and perceptual scores for 326 children on the seven puzzles were subjected to correlational analyses. The suffix PER and LOG will be used to identify the perceptual and logical scores respectively; e.g., B11LOG refers to the logically scores B11 puzzle and B11PER refers to the perceptual scores for the same puzzle.

Reliability and Stability of the Scores

The intercorrelations of the seven puzzles for both sets of the scores for all grades combined and the standardized alpha coefficients are reported in Tables 5 and 6.

Table 5

Correlations Among the Logical Scores for the Grades 1-4 Combined
(N = 326)

	AB12LOG	B7LOG	B8LOG	B9LOG	B10LOG	B11LOG	B12LOG
AB12LOG	1.00						
B7LOG	0.20*	1.00					
B8LOG	0.26*	0.37*	1.00				
B9LOG	0.22*	0.31*	0.46*	1.00			
B10LOG	0.27*	0.30*	0.43*	0.41*	1.00		
B11LOG	0.23*	0.31*	0.45*	0.44*	0.51*	1.00	
B12LOG	0.02	0.02	0.03	-0.04	0.03	0.11	1.00

*significant at .001 level (one-tailed test).

Alpha = .705

Table 6

Correlations Among the Perceptual Scores for Grades 1-4 Combined
(N = 326)

	AB12PER	B7PER	B8PER	B9PER	B10PER	B11PER	B12PER
AB12PER	1.00						
B7PER	0.24*	1.00					
B8PER	0.36*	0.31*	1.00				
B9PER	0.31*	0.20*	0.56*	1.00			
B10PER	0.34*	0.24*	0.57*	0.54*	1.00		
B11PER	0.38*	0.26*	0.52*	0.57*	0.70*	1.00	
B12PER	0.18*	0.06	0.30*	0.29*	0.34*	0.36*	1.00

*significant at .001 level (one-tailed test)

Alpha = .801

Examination of the data in Tables 5 and 6 reveals generally high correlations among both the perceptual and logical scores. Only one correlation among the perceptual scores, that between B7 and B12, is not significant at .001. One logically scored puzzle (B12) also shows relatively low correlations with the other puzzles.

The rationale analysis of B7 showed that it was the only puzzle where repetition of figure does not involve strict symmetry (pp. 22). B12, (pp 24)on the other hand, presents a type of symmetry (or balance) unlike that of the other puzzles; i.e., a type of symmetry are labeled "global balance of information."

Puzzle B12 stands alone in the matrix of logical scores as being uncorrelated with the other puzzles; in fact, if this problem is deleted, the alpha coefficient among the remaining six problems rises to .748. The possible reasons for this finding will be discussed later.

A study of the matrices of correlations by grade level yields a number of interesting findings. Tables 7-14 presents these correlational matrices for each type of score for each grade level.

Table 7

Correlations Among the Logical Scores for Grade 1
(N = 71)

	AB12LOG	B7LOG	B8LOG	B9LOG	B10LOG	B11LOG	B12LOG
AB12LOG	1.00						
B7LOG	-0.09	1.00					
B8LOG	0.16	0.00	1.00				
B9LOG	0.22	0.01	0.37*	1.00			
B10LOG	0.10	0.10	-0.07	0.06	1.00		
B11LOG	0.12	-0.06	0.00	0.26	0.31	1.00	
B12LOG	0.05	-0.05	-0.07	0.02	0.18	0.06	1.00

*significant at .001 level (one-tailed test).

(Alpha = .378)

Table 8

Correlations Among the Perceptual Scores for Grade 1
(N = 71)

	AB12PER	B7PER	B8PER	B9PER	B10PER	B11PER	B12PER
AB12PER	1.00						
B7PER	0.21	1.00					
B8PER	0.23	0.17	1.00				
B9PER	0.22	-0.13	0.32	1.00			
B10PER	0.02	-0.04	0.35*	0.24	1.00		
B11PER	0.07	-0.08	0.17	0.24	0.44*	1.00	
B12PER	-0.08	-0.06	0.08	-0.04	-0.08	-0.06	1.00

*significant at .001 level (one-tailed test).

(Alpha = .450)

Table 9

Correlations Among the Logical Scores for Grade 2
(N = 92)

	AB11LOG	B7LOG	B8LOG	B9LOG	B10LOG	B11LOG	B12LOG
AB12LOG	1.00						
B7LOG	0.21	1.00					
B8LOG	0.29	0.43*	1.00				
B9LOG	0.24	0.20	0.28	1.00			
B10LOG	0.09	0.29	0.49*	0.32*	1.00		
B11LOG	0.25	0.11	0.44*	0.24	0.56*	1.00	
B12LOG	0.14	0.05	0.16	-0.08	0.04	0.19	1.00

*significant at .001 (one-tailed test)

(Alpha = .618)

Table 10

Correlations Among the Perceptual Scores for Grade 2
(N= 92)

	AB12PER	B7PER	B8PER	B9PER	B10PER	B11PER	B12PER
AB12PER	1.00						
B7PER	0.14	1.00					
B8PER	0.28	0.43*	1.00				
B9PER	0.22	0.25	0.50*	1.00			
B10PER	0.36*	0.33*	0.56*	0.49*	1.00		
B11PER	0.37*	0.28	0.54*	0.50*	0.81*	1.00	
B12PER	0.29	0.17	0.38*	0.41*	0.56*	0.60*	1.00

*significant at .001 level (one-tailed test).

(Alpha = .825)

Table 11

Correlations Among the Logical Scores for Grade 3
(N = 92)

	AB12LOG	B7LOG	B8LOG	B9LOG	B10LOG	B11LOG	B12LOG
AB12LOG	1.00						
B7LOG	0.28	1.00					
B8LOG	0.31	0.38*	1.00				
B9LOG	0.32	0.30	0.50*	1.00			
B10LOG	0.48*	0.14	0.46*	0.48*	1.00		
B11LOG	0.27	0.35*	0.48*	0.55*	0.38*	1.00	
B12LOG	-0.13	0.03	0.09	0.08	-0.02	-0.02	1.00

*significant at .001 level (one-tailed test).
(Alpha = .724)

Table 12

Correlations Among the Perceptual Scores for Grade 3

(N = 81)

	AB12PER	B7PER	B8PER	B9PER	B10PER	B11PER	B12PER
AB12PER	1.00						
B7PER	0.26	1.00					
B8PER	0.45*	0.20	1.00				
B9PER	0.45*	0.24	0.67*	1.00			
B10PER	0.38*	0.09	0.57*	0.64*	1.00		
B11PER	0.42*	0.26	0.56*	0.67*	0.59*	1.00	
B12PER	0.22	0.04	0.32	0.37*	0.36*	0.43*	1.00

*significant at .001 (one-tailed test)
(Alpha = .818)

Table 13

Correlations Among the Logical Scores for Grade 4

(N = 82)

	AB12LOG	B7LOG	B8LOG	B9LOG	B10LOG	B11LOG	B12LOG
AB12LOG	1.00						
B7LOG	0.20	1.00					
B8LOG	0.14	0.41*	1.00				
B9LOG	-0.03	0.40*	0.51*	1.00			
B10LOG	0.20	0.42*	0.47*	0.41*	1.00		
B11LOG	0.11	0.54*	0.49*	0.44*	0.51*	1.00	
B12LOG	0.04	0.04	-0.09	-0.07	0.01	0.20	1.00

*significant at .001 level (one-tailed test)
(Alpha = .700)

Table 14

Correlations Among the Perceptual Scores for Grade 4

(N = 82)

	AB12PER	B7PER	B8PER	B9PER	B10PER	B11PER	B12PER
AB12PER	1.00						
B7PER	0.33*	1.00					
B8PER	0.35*	0.36*	1.00				
B9PER	0.23	0.25	0.60*	1.00			
B10PER	0.38*	0.45*	0.63*	0.62*	1.00		
B11PER	0.45*	0.42*	0.57*	0.65*	0.74*	1.00	
B12PER	0.16	0.08	0.32	0.36*	0.32	0.30	1.00

*significant at .001 level (one-tailed test)
(Alpha = .828)

The inspection of these data indicates that the intercorrelations among both the logical and the perceptual scores, as well as the alpha coefficients, generally increase with grade level. However, grade 1 subjects show much lower correlations and reliability compared to the other grades. In fact, there is a relatively sharp increase in the correlations and alphas from grade 1 to 2 as compared to the changes from grade 2 through 3 and 4.

Secondly, the tables show that the perceptual score intercorrelations are consistently higher than the logical score correlations, especially at grade 2.

And finally, Problems B7 and B12 show consistently lower correlations with the other perceptual scores at each grade level, and puzzle B12 consistently has lower correlations with the other puzzles on the logical scoring system.

In conclusion, for subjects in grades 1 through 4, the reliability and stability for both the logical and perceptual scores are relatively high, but certain of the puzzles (B7 and B12) stand out as contributing to a lowering of the alpha coefficients.

Correlations with Age

It was expected that both the logical and the perceptual scores should be correlated with age, but that the logical scores would be positively related, whereas the perceptual scores will be negatively, related to age. The relevant correlation coefficients are presented in Table 15.

Table 15

Correlations Between Age Level and the Logical and Perceptual Scores
(N = 326)

Logical		Perceptual	
AB12LOG	.21*	AB12PER	-.16
B7LOG	.20*	B7PER	-.04
B8LOG	.28*	B8PER	-.20*
B9LOG	.35*	B9PER	-.22*
B10LOG	.29*	B10PER	-.25*
B11LOG	.34*	B11PER	-.26*
B12LOG	.00	B12PER	-.10
TOTLOG	.39*	TOTPER	-.26*

*significant at .001 level (one-tailed test)

The results show a relatively high degree of correlation between both types of scores and age. Moreover, the correlations are all in the predicted direction. Again, however, AB12 stands out among the logical scores as showing the lowest correlations; and likewise, B7 and B12 have the lowest correlations between age and the perceptual scores.

Correlations with Decision Time

As mentioned earlier, many of the subjects were administered both the RCPM and the KRISP (grade 1) or the MFF (grades 2 through 4). The correlations between the RCPM and a latency index on these tests is presented in Table 16.

Table 16

Correlations Between Decision Time and the Logical and Perceptual Scores[1]

(N = 326)

Logical		Perceptual	
AB12LOG	.02	AB12PER	-.06
B7LOG	.92	B7PER	.03
B8LOG	.20	B8PER	-.14
B9LOG	.19	B9PER	-.09
B10LOG	.15	B10PER	-.14
B11LOG	.07	B11PER	-.10
B12LOG	-.01	B12PER	-.06
TOTLOG	.14	TOTPER	-.12

*significant at .001 level (one-tailed test)

[1] Scores were transformed to z-scores for the pooled grade level sample.

The correlations are in the expected direction but unexpectantly low. The TOTLOG correlation with latency of .14 is significant at only the .10 level and the same TOTPER correlation of -.12 only at the .20 level of significance.

Correlations with the Conservation Tests

The Purdue Conservation Tasks were presented to all the children in classroom groups. The correlations between the total Conservation scores and the logical and perceptual RCPM scores are presented in Table 17.

Table 17

Correlations Between Conservation and the Logical and Perceptual Scores

(N = 326)

Logical		Perceptual	
AB12LOG	.17*	AB12PER	-.18*
B7LOG	.20*	B7PER	-.08
B8LOG	.26*	B8PER	-.14*
B9LOG	.28*	B9PER	-.13
B10LOG	.28*	B10PER	-.24*
B11LOG	.24*	B11PER	-.17*
B12LOG	.01*	B12PER	-.05
TOTLOG	.34*	TOTPER	-.21*

The correlations are relatively high and in the predicted directions. As before, B12LOG shows the only low correlation on the logical scale, whereas B7 and B12 have the lowest correlations on the perceptual scoring system.

Discussion

According to Piaget, cognitive development is marked by a twofold interaction of assimilation and accommodation. The child can assimilate his surroundings to existing mental structures or he may "refine" his understanding of the world by changing or modifying cognitive structures (the process of accommodation). The earliest comprehension of reality relies mainly on "figurative" processes of perception, imagining, and imitation. The term graphic collections is used to describe how visual information is assembled according to perceptual form as opposed to the higher order operative or reasoning processes.

The cognitive structures of the particular child at a particular time dictate the strategies for problem solving. Responses to matrix multiplication problems can be used to assess these different strategies. In this study, we used Set B of the RCPM to determine whether the child approached the puzzle problems using logical (in the Piagetian sense), or perceptual (figurative) processes. A rational scoring system was generated so that each possible choice could be associated with degree of logical and perceptual solution type. The logical score for a particular choice was based on appropriate utilization of both the row and column dimension information, whereas the perceptual score for the same response choice depended on: a) whether it represented a "repetition of figure" and/or b) on its contribution to completion of the symmetry of the total puzzle configuration.

The obtained reliability correlations (alpha coefficients) indicated the logical scoring system was reliable and stable across grades 1 through 4. The perceptual scores, however, were reliable only for grades 2, 3, and 4. A plausible explanation for this finding is that the characteristics of puzzles B7 and B12 were such as to reduce the reliability. Puzzle B7 was the only one in which repetition of figure did not involve symmetry. This tends to strengthen our interpretation that symmetry, rather than repetition of figure, is a major factor in the perceptual strategy. Puzzle B12 exhibits a form of symmetry which is unlike that of any of the other puzzles; i.e., the "balance" of information is along the diagonal. Thus, B12 responses may fail to correlate with other puzzle scores because its symmetrical features are simply not captured by the scoring system (see pp. 24)

The prediction concerning the relationship between age and the scoring systems was generally confirmed. Therefore, crucial evidence is now available that the scores do reflect logical and perceptual strategies; i.e., Piagetian theory implies the period of "figurative" problem solution should occur prior to that of "logical" operational solutions.

The data for latency of response, on the other hand, lended only slight support to the intuitive contention that perceptual strategies should require shorter decision time than the logical strategy. The numerous factors that influence solution time for such complex problems makes it difficult to specify what might have confounded the expectation. In any case, both correlations with the conservation measure (.34 for the total logical score and .21 with the total perceptual score) were significant beyond the .001 level. Thus, there is good evidence for construct validity despite the fact that puzzles B7 and B12 had low correlations with the conservation test.

It is concluded that the Piagetian theoretical approach adopted here for analyzing error choice on matrix multiplication puzzles has considerable merit. The usual criterion of right/wrong scoring of the RCPM, however, seems to yield a good measure of the general level of logical operational thought. In addition, the supplementary score based on the notion of dual level cognitive processes (i.e., figurative and operational) provides information about development level and performance on other problem-solving tasks. However, because the RCPM was not originally intended to reflect Piagetian theory, and the figurative versus operative aspects of matrix problems, this type of error analysis is of limited use. A new set of matrix problems and answer choices needs to be created to more clearly represent a "pure" measure of these theoretically defined processes and the relevant cognitive developmental abilities.

Appendix A

Instructions for the Administration of the Raven's Coloured Progressive Matrices Test

1. The test booklets, answer sheets, and pencils should be distributed to the children. The examiners should have written each child's name on an answer sheet.

2. Once the children have been seated, introduce yourself and say:
   KEEP THE RED BOOK ON YOUR DESK AND DO NOT OPEN IT UNTIL I TELL YOU TO DO SO. DO EACH OF YOU HAVE A RED BOOK, WHITE ANSWER SHEET, AND PENCIL? DO NOT MAKE ANY MARKS IN THE RED BOOK. DO NOT WRITE ON YOUR ANSWER SHEET UNTIL I TELL YOU TO DO SO.

   OPEN THE BOOK TO THE FIRST PAGE. LOOK AT THE TOP PART. IT IS A GREEN PUZZLE WHICH HAS A PIECE LEFT OUT. (Demonstrate) EACH OF THE PIECES BELOW THE PUZZLE IS THE RIGHT SHAPE, BUT ONLY ONE OF THE PIECES LOOKS RIGHT. EACH PIECE IS NUMBERED. (Note position of numbers.) WHICH PIECE WOULD YOU PUT IN THE PUZZLE? (Wait for the answer.) YES, NUMBER 4 IS THE RIGHT PIECE. NOW, FIND THE DOG ON YOUR ANSWER SHEET. (Demonstrate) SEE THE NUMBERS NEXT TO IT? THEY ARE THE SAME AS THE NUMBERS ABOVE THE PIECES IN THE RED BOOK. (Demonstrate) CIRCLE NUMBER 4 ON YOUR ANSWER SHEET NEXT TO THE DOG (Demonstrate). NUMBER 4 IS THE RIGHT PIECE FOR THIS PUZZLE. DO NOT CIRCLE ANY OTHER NUMBERS. LAY YOUR PENCIL DOWN BY YOUR ANSWER SHEET. DO NOT TURN THE PAGE UNTIL I TELL YOU TO DO SO. (Check to see if all children have circled number 4 by the dog.)

   NOW, TURN TO THE NEXT PUZZLE. IT IS ORANGE. (Demonstrate) DO NOT SAY WHICH PIECE GOES IN THE PUZZLE. DECIDE WHICH PIECE GOES IN THE PUZZLE. FIND THE ELEPHANT ON YOUR ANSWER SHEET. CIRCLE THE NUMBER NEXT TO THE ELEPHANT WHICH IS THE SAME NUMBER AS THE PIECE YOU PICKED. (Demonstrate, but don't point out the answer yet.) AFTER YOU CIRCLE YOUR ANSWER. LAY YOUR PENCIL DOWN.

3. Check to see that all the children have their answer in the right place on their answer sheet. Preceed with the test, one puzzle at a time, reminding children at every third puzzle to check their answer to be sure that they have chosen the right piece.

Appendix B

Table I

Total Sample (N = 326)
Varimax Rotated Factor Matrix
After Rotation with Kaiser Normalization

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
A7	-.00180	.24810	.23262	.50759
A8	.14318	.21082	.05223	.51013
A9	.03360	.39877	.23517	.33823
A10	.17076	.44328	.10411	.35964
A11	.21382	.28055	.19634	.40567
A12	.06750	-.05222	.17042	.75896
AB4	-.00121	.66690	.21316	.10439
AB5	.14449	.68436	.02452	.12167
AB6	.20178	.70205	-.04157	.21255
AB7	.13004	.53284	.25310	.19110
AB8	.17825	.38967	.34837	.19160
AB9	.16263	.15585	.66252	.02581
AB10	.26809	.35630	.45530	-.09111
AB11	.17153	.20980	-.09126	.40931
AB12	.46020	-.05339	.42683	.08827
B3	.05109	.33330	.36345	.08820
B4	.11153	.58300	.13673	.08478
B5	.08148	.31891	.52136	.33793
B6	.07815	.04892	.63966	.25685
B7	.45872	.21632	.26884	.23649
B8	.74630	.10533	.28853	-.00952
B9	.75030	.13642	.11997	.06482
B10	.75992	.21926	.17081	.12608
B11	.81387	.13496	.12590	.19875
B12	.55773	.06909	-.13537	.10982

Appendix B

Table II

Grade 1 and 2 (N = 163)
Varimax Rotated Factor Matrix
After Rotation with Kaiser Normalization

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
A7	.11514	-.00741	.22008	.51784
A8	.20329	.17915	.09091	.29513
A9	.53817	-.02139	.00607	.42819
A10	.43707	.29291	.03080	.28845
A11	.17549	.41591	.22435	.35243
A12	-.00355	.00655	-.05506	.75584
AB4	.59958	-.10834	.14469	.16659
AB5	.71640	.10368	.11637	-.06347
AB6	.74797	.18585	-.06268	.05642
AB7	.38987	.16080	.35769	.16569
AB8	.48206	.15750	.20259	.06184
AB9	-.00336	.12811	.68886	-.02312
AB10	.16590	.18817	.63152	-.16816
AB11	.31782	.12538	-.07879	.27352
AB12	-.15426	.51092	.22253	.07490
B3	.38123	-.02434	.38356	.21775
B4	.59652	.08218	.28712	-.00144
B5	.32446	.12644	.55465	.33650
B6	.09980	.08542	.50398	.26684
B7	.43106	.24747	.11939	.13160
B8	.24502	.62636	.20986	-.08393
B9	.13722	.69674	-.01997	.04646
B10	.31121	.74428	.03585	-.09667
B11	.11330	.83881	.04764	.08316
B12	.02230	.53779	.10752	.11455

Appendix B

Table III

Grade 3 and 4 (N = 163)
Varimax Rotated Factor Matrix
After Rotation with Kaiser Normalization

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
A7	-.00477	.40788	.19100	.38301
A8	.06836	.34857	.16805	.31881
A9	.12508	.60268	.34357	-.20762
A10	.08875	.60866	.09153	.20827
A11	.10714	.60919	.18935	-.03119
A12	.05205	.10928	.40946	.39480
AB4	.04828	.57572	.18211	.23957
AB5	.10065	.27210	.08150	.62730
AB6	.13623	.42534	.05606	.54972
AB7	.05930	.48595	.08161	.50445
AB8	.12097	.15398	.50034	.32924
AB9	.17140	.24460	.49764	.08644
AB10	.33158	.42859	.17324	.14616
AB11	.14086	-.12179	.11797	.64792
AB12	.44208	.01416	.36105	.14326
B3	.12614	.01579	.49467	-.05922
B4	.09591	.60030	-.12980	.06396
B5	.09836	.24961	.58169	.32534
B6	.14472	.10729	.72007	.09628
B7	.54528	.11458	.36596	.17283
B8	.80224	.01444	.17879	.05422
B9	.78842	.14927	.11062	-.04826
B10	.75388	.22646	.22957	.09531
B11	.81246	.21364	.12748	.06676
B12	.53678	-.04509	-.26766	.31009

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GROWTH OF LOGICAL THOUGHT IN RURAL AND URBAN ENVIRONMENTS[1]

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November 1973

Prepared for the
MATHEMAGENIC ACTIVITIES PROGRAM - FOLLOW THROUGH
of the
University of Georgia
Charles D. Smock, Director

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[1] This report is based on a study entitled Cognitive Growth Among Rural and Urban Children by N. Mohseni and C. D. Smock. That study and this report were supported in part by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-8-522478-4617 (287) Department of HEW, U. S. Office of Education, and the Department of Psychology, University of Georgia. The opinions expressed herein, however, do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

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PS 011512

Introduction

Most of us take for granted that, when we slice the Sunday ham, we will have just as much meat as when we started, even though we now have, say, 14 juicy slices. Even more, we know that the slices when weighed together will add up to the original weight of the whole, cooked ham.

These facts seem obvious to an adult. But not until the age of about 7 to 11 years do children reach an adequate understanding of the relationships among the size (or weight) of the ham, the action of cutting, and the smaller parts that result.

Prior to reaching this understanding the young child is likely to respond to the question: "Is there just as much ham now that it's sliced?" with the answer, "No, there is more ham." If we ask the child, "Does the sliced ham weigh as much as it did before we cut it?" he is likely to say, "No, it weighs more." The child is fooled by the transformed appearance of the object.

Jean Piaget, a Swiss child-developmental theorist and researcher, suggests that to answer correctly these kinds of questions, the child must have ability to "conserve." To conserve simply means to understand that certain qualities of an object (like size or weight) do not change even if that object "looks different" (for example, sliced into smaller pieces) under different conditions. Thus, conservation requires the capability to focus simultaneously on several different aspects of the situation - to focus on what is happening to the object rather than on what it looks like after some change has taken place.

Conservation ability, according to Piaget, reflects the development of logical reasoning. A second type of task that reflects the growth of logical thought processes is that of seriation; i.e., the ordering of objects according to some property or certain characteristics. For example, when we take a picture of the family at the Christmas gathering, we arrange the family from the shortest in the front row to the tallest in the rear, making sure, therefore, that everyone's beaming face will be seen in the photo later.

About the age of 6-7 years a child begins to use systematically such strategies as arranging a row of sticks from shortest to tallest, or ordering two sets of items in one-to-one correspondence: tallest with tallest, shortest with shortest, and so on. Not only that, but after the age of 7 a child realizes that if Uncle Joe is taller than Aunt Sally in one family photo, and if Aunt Sally is taller than Cousin Mary in another photo, then Uncle Joe must be taller than Cousin Mary too. Such transitivity judgments reflect more sophisticated logical reasoning than simply using immediate perceptual uses.

Another type of problem-solving task of relevance for studying intellectual development requires the child to arrange things in the class of things to which they belong. Ability to classify objects in multiple ways represents the beginning of ability to reason creatively; i.e., produce novel solutions to problems.

A farmer, for example, has no trouble taking his bumper crop of corn and dividing it into "good" and "poor" for sale at the market. And yet it is not until the ages between 7 and 11 years that a child realizes that the two groups of "good corn" and "poor corn" both belong to the larger class of items "corn," and that these groups may each be further divided into "larger ears" and "small ears."

All three tasks - conservation, seriation and classification - require the child to make his judgments on the basis of logical thought rather than on the appearance of objects.

How does logical reasoning reflected in conservation, seriation and classification tasks come about? What helps or hinders the appearance of these reasoning abilities in children?

To answer some of these kinds of questions, a study was conducted by Dr. Nikki Mohseni, from the University of Tehran, in collaboration with Dr. C. D. Smock, University of Georgia-Follow Through. Dr. Mohseni came to the University of Georgia in 1971 as a post-doctoral research associate to further study the extent to which cultural background of a child influences the age at which the thinking skills involved in logical reasoning appear.

Method

Two hundred and forty (240) Follow Through and Non-Follow Through children from 7 through 11 years of age, were selected from two Follow Through communities. The children from nine public schools in Lee County, Virginia were defined as a "rural" group, whereas children from two schools in Berkeley, California made up the "urban" group.

Twelve tasks, developed by Piaget to study logical thought, were given to each of the 240 children. The tasks represented the three types of logical problems mentioned above:[2]

Conservation	Seriation	Classification
Discontinuous (1) Quantity	Seriation (3)	All-or-Some (7)
Continuous (2) Quantity	Intermediate (4) Seriation	Flowers (8)
Conservation of (10) Weight	Transitivity of (5) Length	Beads (9)
Conservation of (12) Volume	Double Seriation (6)	
	Transitivity of (11) Weight	

Scoring of performance on these tasks was according to a three point scale. Criteria for each level of response are presented below:

Score	Response
0	Child responded incorrectly, lacked logical reasoning, and seemed to make his response on "how things looked."
1	Child responded correctly, but showed a mixture of logical reasoning and reliance on how things appeared. He could easily be led to make an incorrect response if the appearance of the object was emphasized.
2	Child responded correctly and revealed accurate and stable reasoning abilities even when the appearance changed drastically.

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[2] The numbers in parentheses reflect the order of development of the ability to perform the tasks. For example, the conservation of quantity would be expected to be successfully performed by a 7-year-old child, whereas conservation of volume is an ability expected to appear only later; i.e., after 9 years of age.

The following summaries of task procedures provide a glimpse at what each was designed to measure :

1. Discontinuous quantity: Two jars of equal size contain an equal number of beads. Beads from one jar are poured into a tall, thin cylinder, and the child is asked if the same amount of beads are in the cylinder as there are in the jar remaining.

2. Continuous quantity: a ball of clay is made into a "snake" or a "pancake" or several little balls. The child is asked if the amount remains the same after each transformation.

3. Seriation

   a. Relative position: after the child has arranged a series of 10 cardboard dolls from tallest to shortest, the child is asked how many dolls are taller than the middle one, and how many are shorter.

   b. Intermediate: the child is asked to place a middle-sized doll in its correct position in the series.

5. Transitivity of length: after the child agrees that a blue doll is taller than a white doll, the blue is removed. The white doll is then compared to a shorter red doll. The child then is asked which is tallest, the (first) blue doll or the (last) red one.

6. Double seriation: the child is asked to arrange 10 dolls from tallest to shortest, and to match 10 canes from tallest to shortest to the corresponding doll.

7. All-or-some: three types of colored blocks are presented to the child and the child is asked: "Are all the circles red?" "Are all the red things circles?" "Are all the squares green?" "Are all the green things square?"

8. Flowers: given 11 plastic flowers (eight white/three yellow) the child is asked if there are more plastic flowers or more white flowers.

9. Beads: given 13 wooden beads (ten red/three blue) on a string, the child is asked if there are more wooden beads or more red beads.

10. Conservation of weight: a ball of clay is made into a "snake," then a "pancake" and then several little balls. The child is asked if the weight remains the same after each transformation, and then is allowed to verify his statement by weighing the clay in a two pan beam-balance scale.

11. Transitivity of weight: three bottles are weighed in the following fashion in a two-pan beam scale: the middle bottle with the light bottle, and the middle weight bottle with the heavy bottle. The child is asked, "Which one will be heavier, the last or the first one?"

12. Conservation of volume: a ball of clay is reshaped into a bar, into a pancake, and into little balls. Each time the child is asked to predict where the water level in a beaker (3/4 filled with water) will rise when the different shaped clay is placed in the water.

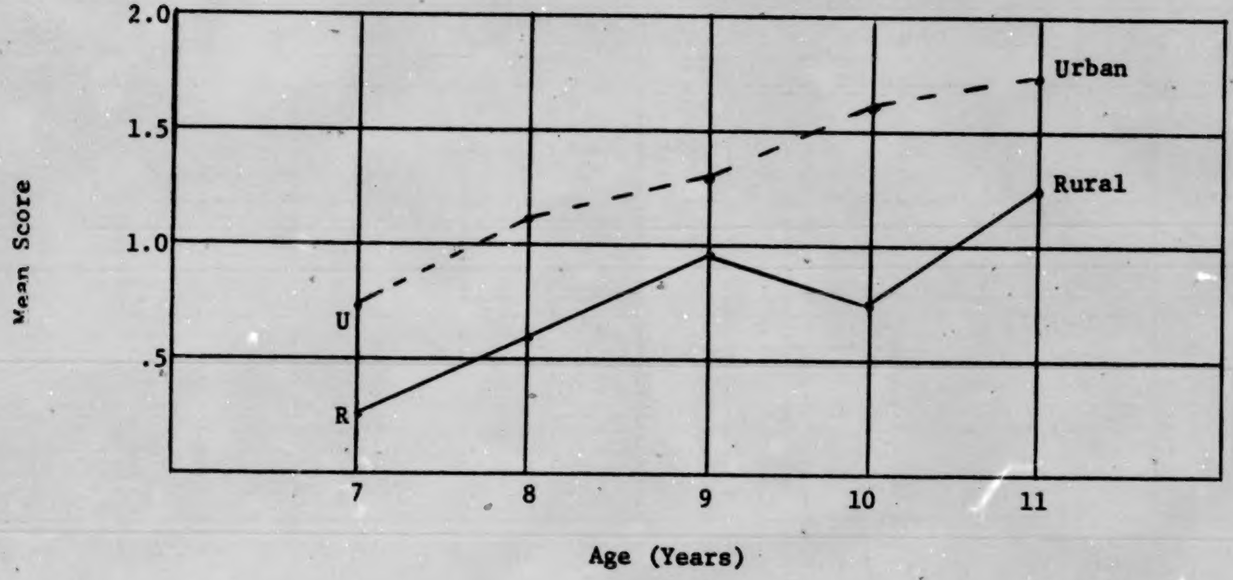
Results

The results of the study indicate that the reasoning abilities of urban and rural children develop in similar ways. That is, both groups grow away from being "fooled" by the appearance of things and toward use of logical reasoning.

In figure 1, for example, a steady increase in the use of logical reasoning for both rural and urban children between the ages of 7 through 11 years (on a moderately complex classification task) is illustrated.

Figure 1

Differences in Rural and Urban children on the All-or-Some Tasks between Age 7 and Age 11



It would appear from the trends in this graph that the rural children, at a later age than their urban counterparts, rely on the perceptual qualities (or appearance) of the object. The first appearance of a "transition" judgment[3] by the urban group appears at age 8 or 9, while the first appearance of a "transition" judgment by the rural group does not occur until the age of 11 years. This age lag in the appearance of transition judgments by the rural group appears on most of the tasks used in this study.

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[3] Refer to scoring system on page 4.

In each community, Follow Through (FT) children performed significantly better on some tasks than Non-Follow Through (NFT) children, and vice versa. Specific comparisons, however, are more informative. If, for example, we compare only NFT children at the ages of 7 and 8 years for the two communities we note, in both Figures 2 and 3, that urban children score consistently higher than their rural counterparts on all tasks.

Figure 2

Comparison of NFT Rural and NFT Urban Children
at Age 7 on All Problem-Solving Tasks

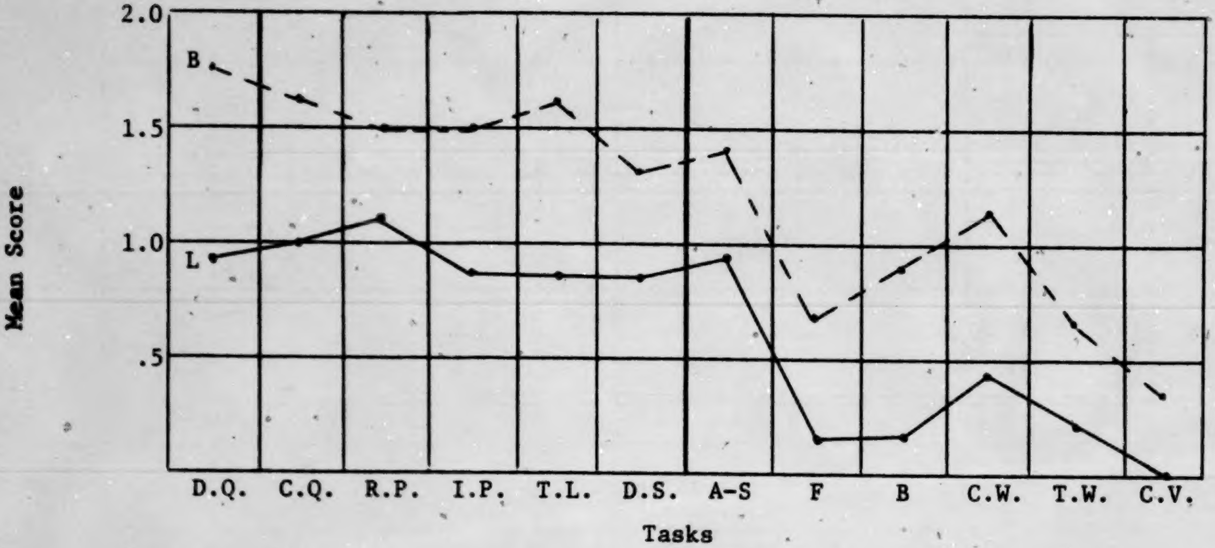
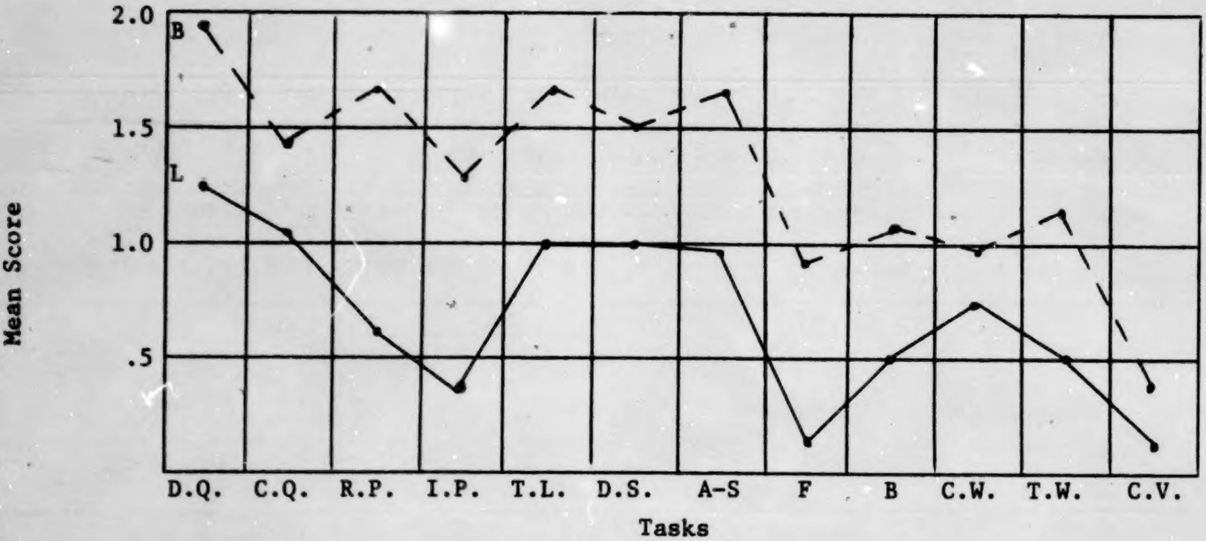


Figure 3

Comparison of NFT Rural and NFT Urban Children
at Age 8 on All Problem-Solving Tasks



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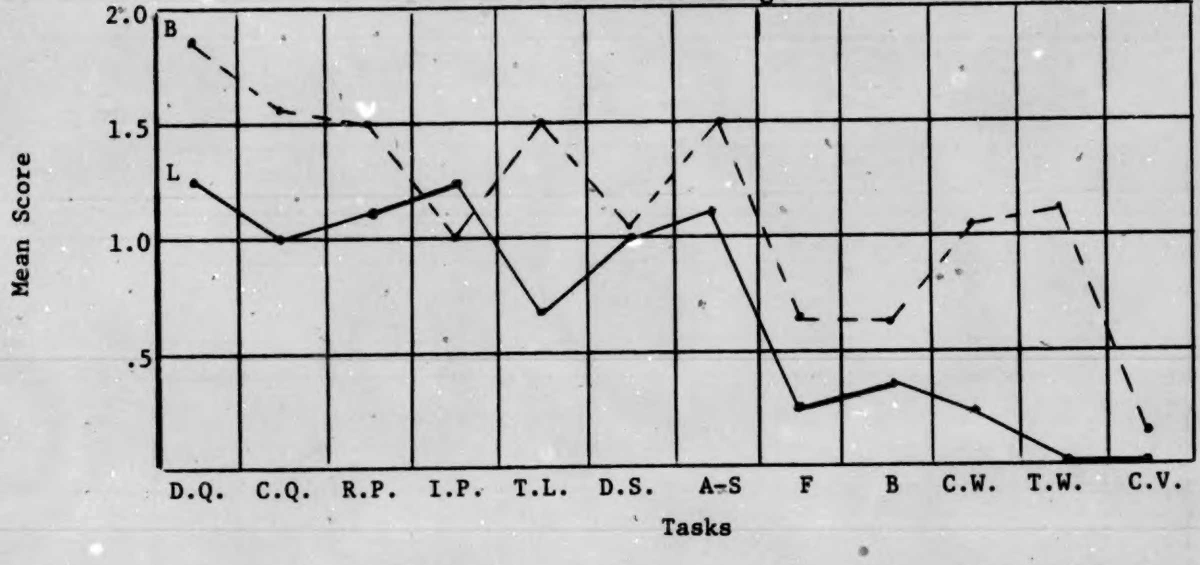
[4] In these figures, tasks are represented in increasing order of difficulty.

Clearly, the rural/urban differences are present when only Non Follow Through children are compared within each community. However, the Follow Through-MAP intervention program seems to modify the differences between the Rural and Urban groups. In Figure 4, note that the Lee County FT-MAP children generally do not perform as well as the Berkeley FT children at age 7.

Figure 4

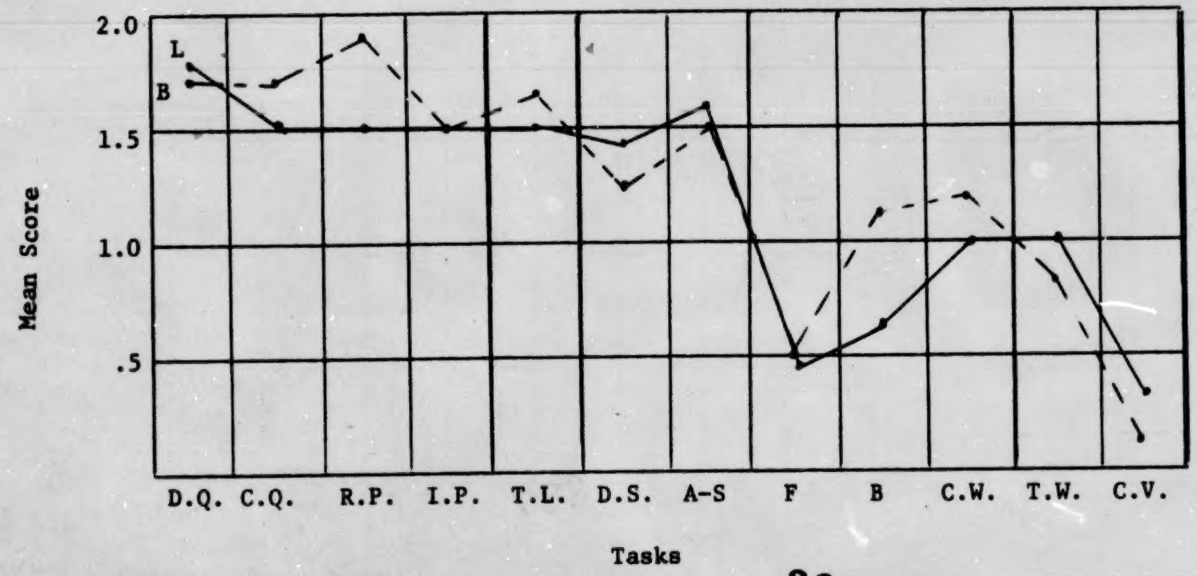
Comparison of FT Rural and Urban Children on All Tasks at Age 7



At the age of 8 years, however, the urban and rural FT children show remarkably comparable performance across all tasks, as illustrated in Figure 5.

Figure 5

Comparison of FT Rural and Urban Children on All Tasks at Age 8



At this point we may ask, are the urban FT children at age 8 simply falling behind NFT urban children, or are the Lee County rural FT children really performing better?

Figures 6 and 7 indicate the urban FT children continue to perform like their NFT counterparts at age 8, while the rural FT children perform better across all tasks than their NFT counterparts for the same age group.

Figure 6

Comparison of FT and NFT Urban Children
on All Tasks at Age 8

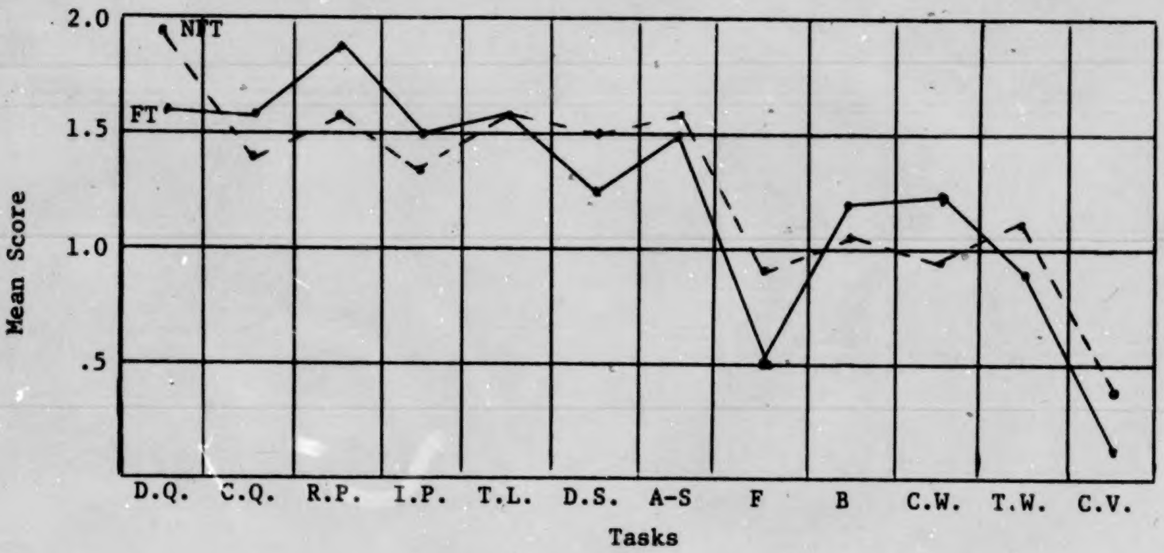
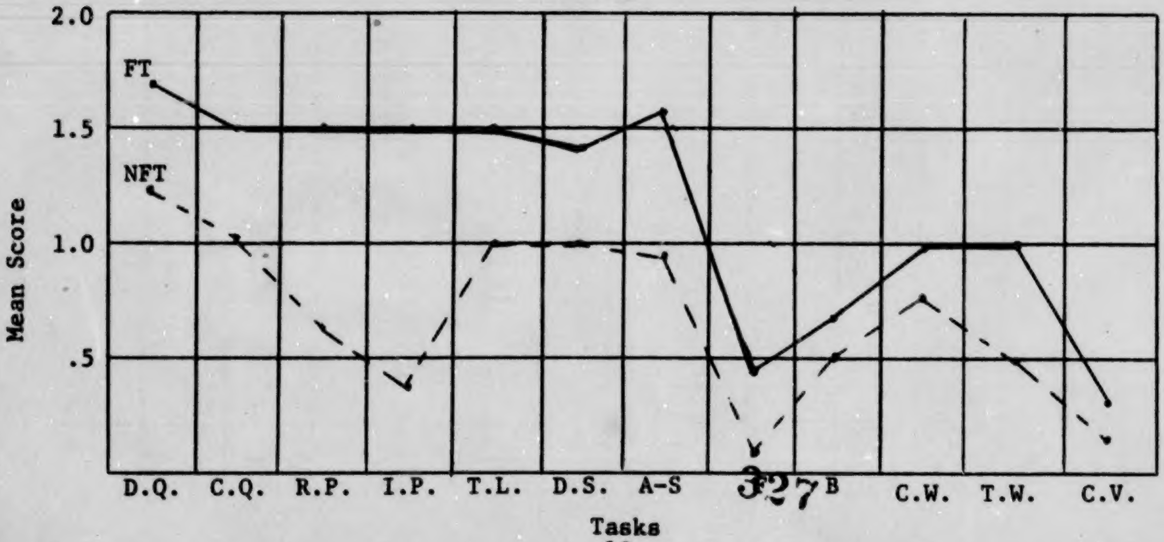


Figure 7
Comparison of FT and NFT Rural Children
on All Tasks at Age 8



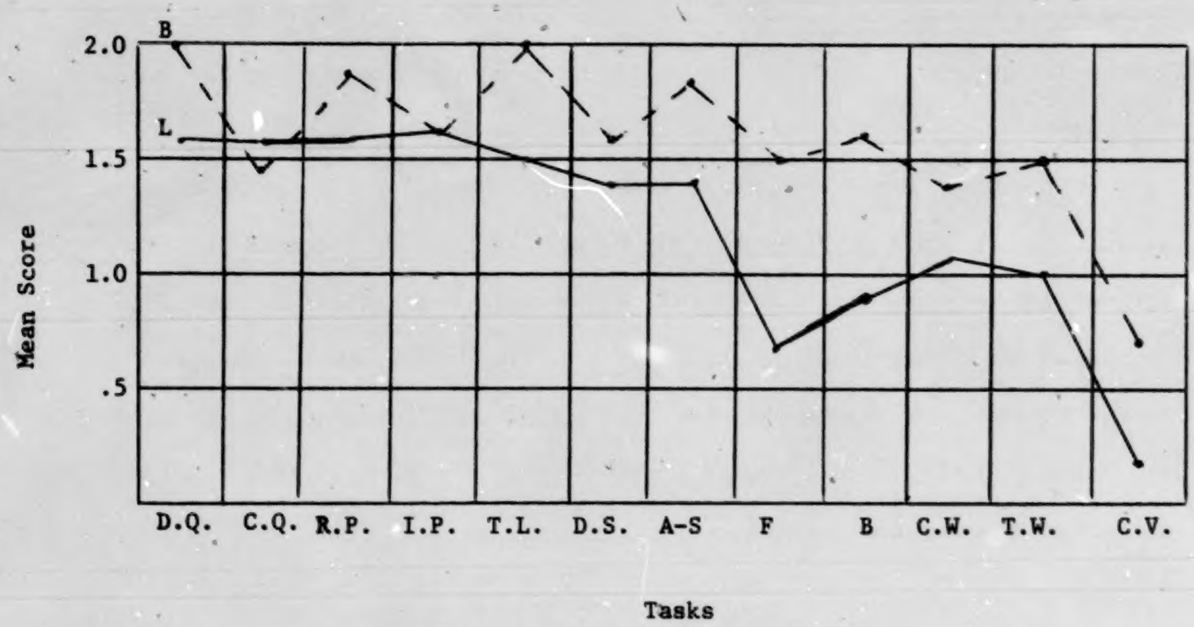
It would seem, therefore, that at age 8, the similarity on performance of the rural FT children to the performance by the urban FT pupils actually occurs because the Lee County FT 8-year-olds are performing better than their NFT counterparts.

At age 9, however, the rural FT children fail to perform as well as their urban counterparts (see Figure 8) when all tasks are considered.

Figure 8

Comparison of FT Urban and Rural Children

on All Tasks at Age 9



The discrepancy in performance between the 8-and 9-year-old FT pupils in Lee County may be the result of the differences in the Lee County-MAP program maturity at each grade level. That is, the 8-year-old FT children in this study entered the second year of a MAP Grade Two class, whereas the 9-year-old FT pupils entered the first year of a MAP Grade Three program.

Conclusion

Differences between rural and urban children on conservation task performance are most apparent with the non-Follow Through children in this study. The Follow Through intervention program seems to have eliminated most of these differences.

One practical conclusion that may be drawn regarding the success of FT-MAP training, as it is viewed in the performance of the rural FT children in Lee County, is that an active attempt must be made to get the child from a rural environment to verbalize the problem-solving strategies he is using. Verbalization, especially verbal exchanges with others (e.g., teacher asking open-ended questions), assists the child in focusing attention on the relevant aspects of the task and facilitates problem solution.

It does not appear from these data that the rural child cannot perform as well as his urban counterpart, but rather that active coordination of actions and conceptualization of relevant sequence of actions is typically not employed. Educational programs, such as the FT-MAP, that emphasize social interactions (among children, and between child and adult) and activity based learning tasks, are an important step toward providing a better classroom learning environment.

Role Taking and Egocentrisms

by

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Paper Presented

at the

Southeastern Society for Research in Child Development

at Chapel Hill, North Carolina, March 8, 1974

PS 011512

This report is based on activities supported (in part) by the Mathemagenic Activities Program-Follow Through, C. D. Smock, Director, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

This paper is concerned with the manner in which the young child learns to think about his or her social reality, a reality which the child is in the process of constructing. There are two principal varieties of role taking, perceptual role taking and conceptual role taking; the purpose of this paper is to attempt to make a conceptual clarification of the concept egocentrism as it is used in conceptual role taking. In addition ambiguities in the use of the work "structure" will be pointed out.

Role taking research acquired direction and impetus from the publication of a series of pilot studies by Flavell, Botkin, Fry, Wright, and Jarvis (1968); and this work is placed in historical perspective by an overview of previous role taking research in their book. A number of different tasks were used by Flavell et al., however all were designed so that the subject was required to take a role which was specifiably different from his own. The subject's task was to demonstrate the capability of making certain coordinations in the data presented; coordinations which imply the ability of the subject to take the role perspective of another person. In one of the tasks used by Flavell et al., subjects were presented with a sequence of cartoon pictures and asked to describe the story represented. Virtually all the subjects were able to describe the story; thus, minimal inquiry from the experimenter was required to establish the key elements in the story. Then certain pictures were removed, an experimenter aide entered, and the subject was asked to describe the story from the aide's viewpoint. If the subject failed to mention certain key elements in the story he was asked about these features; the purpose of these procedures being to discover whether he was capable of taking the perspective of the experimenter aide. Subsequent research on this type of task supports the developmental sequence described for it (Selman, 1971 a, b; Irwin and Ambron, 1972; and Chandler, 1972, 1973). Also different techniques have been used to investigate the development of the ability to think about what another person is thinking, and they lend further support to the basic sequence described by Flavell et al., DeVries (1970), Miller, Kessel, and Flavell (1970), and Selman (1973).

The descriptions of the development of the ability to consider the other person in each of the studies mentioned above are complementary. This 'differentiation' has been described in the following way: (1) initially the child fails to distinguish between the thoughts and perceptions of the self and the other; (2) the child's sense of self is distinguished from the other but there is a failure to see any commonality of thoughts between the self and the other; (3) the child now attributes its own ideas to the other child but sees the other as having similar perspectives to himself; and (4) the child is now aware that the other child has perspectives which may or may no not be similar to his own (Selman, 1971a). The similarities between this view and the original description of this development by Piaget (in Elkind, 1961) is evident: (1) the child is initially unable to judge which is the right hand and which is the left hand of an experimenter sitting opposite; (2) the child begins to understand the difference but makes frequent errors in making the judgment; (3) the child can do the transformation when thinking carefully about the answer; and (4) the child can make this transformation with ease. Similar progressions may be described for each of the different tasks mentioned above.

An important research issue has been stated by a number of researchers, but I believe it has not been resolved. This issue concerns the relation between the acquisition of physical concepts and the acquisition of the social understandings which have just been described. Piaget has stated this issue from time to time (1932, 1940, 1950) maintaining that these two sorts of concepts develop together, in parallel. His argument is that some basic understanding of perspective is necessary for the development of cooperative play; and further that cooperative play is the foundation for the experience of contradiction which is necessary to the development of logical operations. However, the way in which these different sets of structures interact is not at all understood. In order to look at this issue it is necessary to clarify the meaning of two related terms which have been used in the description of this developmental sequence. These terms are egocentrism and structure.

Recent papers by Borke (1972) and Chandler and Greenspan (1972) show clearly the potentialities for confusion over the meaning of the word egocentrism. Borke maintained that young children aged about three and four years were not egocentric. This is about three years prior to the age at which other researchers report this development. Misguided criticisms of Piaget's age norms are still in vogue in some quarters (e.g., sociology - Denzin 1972); however the bulk of the research on egocentrism indicated the ages six to eight to be critical. For this reason Chandler and Greenspan felt it necessary to look at Borke's study more closely. They performed another study using cartoons in which the subjects had two tasks to perform. The first part involved the identification of emotions in principal characters in the cartoon; and then the subjects were required to take a role which required understanding a different perspective. They found that while young children aged about three and four could identify emotions in other children in the cartoons, they were not able to take the role perspective which was different from their own.

The difficulty arose because of the ambiguity of the phrase 'taking another's perspective'; which may mean that the subject is unable to realize that other children have different perspectives or, alternately, it may mean that the subject confuses his perspective with other children's perspectives in certain sorts of tasks. Borke's concern was to emphasize that young children could understand the emotions and feelings of others, in some sense. Her findings that young children can identify the emotional perspectives of others is consistent with common sense, and has received additional support from a study by Mood and Johnson (1973) who showed that the child's ability to do this was independent of the child's own affect state. Borke's concern was not well founded. For example, Piaget (1932) emphasized the importance of presenting information to children from a number of different perspectives, so that the child may have the opportunity to understand meanings over and above those which are grasped first.

When egocentrism is identified as a decentering problem, as it should be, questions about the ability to take the perspective of another must be phrased with reference to the ability to decenter. This is recognized generally by many researchers in the case of conservation research; and preoperational thought is described with reference to the ability to decenter from dominant perceptual attributes. This point is made very clear in the following quote:

> 'The systematically distorting assimilations of sensorimotor or initial representational stages, which distort because they are not accompanied by adequate accommodations, mean that the subject remains centered on his own actions and his own viewpoint. On the other hand, the generally emerging equilibrium between assimilation and accommodation is the result of successive decentrations, which make it possible for the subject to take the point of view of the subjects or objects themselves. We formerly described this process merely in terms of socialization and egocentrism. But is it far more general and fundamental to knowledge in all its forms. For cognitive progress is not only assimilation of information; it entails a systematic decentration process which is a necessary condition of objectivity itself.' (Piaget, 1970. p. 710).

Thus, while Borke's study may be criticised becuase it did not stress that the perspective to be taken should be different; the Chandler and Greenspan study does not measure decentering cleanly. More specifically, Chandler and Greenspan's measure of egocentrism is an index of privileged information in the account of the cartoon given by the subject, who took the role of the late arriving bystander. (Privileged information being that which the structure of the task denies to the bystander.) The issue of whether the subject can recognize that there is a different role to be taken in this task is disguised. The ambiguity with which I am concerned rests in this disguise. The offered solution to this ambiguity depends on the definition of egocentrism in terms of decentering. The issue is to measure egocentrism so that the young child's ability to decenter from his own perspective is assessed and distinguished from his ability to cope with the content of this other perspective. Thus, a distinction needs to be made between responses which fail to exhibit an awareness that the "other's" response will be different, and responses which exhibit awareness of this dimension but which then include elements of the subject's own perspective in the response.

Another difficulty in the research stems from the different meanings which may be applied to the word structure. Piaget (1967) maintained that all behavioral regularity implied some structure; however, the use of the word in the phrase "operational structures" has a more complex set of referents. In the more recent Genevan publications, the distinction between operative and figurative structures is emphasized (Smock, 1973). 'Operative' implies the reversibility of an action sequence, together with logic-mathematical group properties. The recent role taking research, which I have mentioned, has not made any attempt to follow these conventions. Since

Flavell et al.'s work was explicitly described as being a collection of pilot studies, and since the other studies quoted tend to follow in this tradition, it would be unjust to condemn such looseness. However, at this time it seems to be important to call for research on the operative structures which can be inferred on the basis of the general agreement about the nature of the stages through which children develop. The stages described in the literature have not been specified sufficiently clearly for researchers to understand what is being coordinated in the structural evolution of, or more correctly, construction of role taking abilities.

One strategy which would begin to research the nature of the relation between emerging physical structures and social role taking structures could follow the procedures used by Inhelder and Sinclair (1969) in their investigation of the relations between associated logical structures and conservation structures. Essentially the procedure was to establish the structural level of each subject, then to administer training for structural advances for each type of structure. They found that training for logical structures generalized to the conservation structures, but not vice versa. The clearest difference between this type of research and the American research rests on the criteria used to infer structure. These criteria include (1) using a variety of different types of test which all require the same type of cognitive structure, (2) requiring justifications, (3) providing counter-suggestions, and (4) giving a delayed post-test.

Recent American research on the relation between the development of physical structure and social role taking structure has been preoccupied with factor analyzing scores obtained from different cognitive and role taking structure tasks (Rubin, 1973, and Hollos and Cowan, 1973). The Rubin study provided support for the hypothesis that as age increases egocentric responses decrease; and the Hollos and Cowan study provided tentative evidence for the existence of two orthogonal factors, one on which the conservation and classification measures loaded, and the other on which the role taking measures loaded. There was no attempt in either of these studies to investigate the manner in which these different structures were related to each other, or to try to understand what coordinations are necessary to the solution of the role taking tasks.

I have performed some pilot studies to determine whether the cartoon studies which I mentioned earlier could be solved by largely preoperational children using figurative processes. I began thinking about this after observing four KG children perform tasks like those used by Chandler and Greenspan with no apparent difficulty. These children seemed quite aware in most instances[1] (three children in all instances, and one in the majority of instances) that the late arriving bystander would view a new sequence differently; and they also gave many non-egocentric responses to these cartoons, as defined by Chandler and Greenspan (1973). For these reasons I think that it is most important to distinguish between the subject's understanding that the other child has a different perspective, the process by means of which the subject supplies content to what the late arriving bystander is thinking. When the child does realize that the late arriving bystander has a different perspective, he or she can attend to the materials at hand (the remaining cartoon sequence) and give a solution which is arrived at by similar processes to those which enabled the child to produce a story to the cartoon sequence initially. I believe that it is the failure to distinguish between these processes which led to the controversy between

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[1] By "instance" I mean any question, following any cartoon, which allows inference into the child's egocentricity.

Borke on the one hand and Chandler and Greenspan on the other; and further, a distinction which is basic to resolving the ambiguity in the phrase "taking the other's perspective".

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CHILDREN'S CONCEPTION OF REALITY: SOME IMPLICATIONS FOR EDUCATION

by

Charles D. Smock

1968

Second Printing

September, 1977

This report is based on activities supported (in part) by the Mathemagenic Activities Program-Follow Through, University of Georgia, under Grant No. OEG-0-8-522478-4617 (287) Department of HEW, U. S. Office of Education. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

PS 011512

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Vol. 1, No. 3, Spring, 1968 Copyrighted 1968.

CHILDREN'S CONCEPTION OF REALITY: SOME IMPLICATIONS FOR EDUCATION

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I would not go so far as many experts in the area, but I do realize the tremendous role that education must play in the challenges that confront our society and the world today. Not only are we confronted with the challenge and magnificance of a knowledge explosion in many areas, but there is currently an increased awareness of the role that education _must_ play in creating truly equal educational opportunities for all people, at home and abroad. The transformation our society is undergoing, we hope, will be directed on such a course that our traditional values and beliefs concerning the nature of human existence will be maintained.

These challenges make educational theory and practice the most exciting of all time. Certainly some of the most significant advances have been in the technological sector; e.g., the teaching machine. However, in my opinion, we have recently devoted relatively too much time to teaching machines and too little to the characteristics of our "learning machines"; that is, to the children who are the targets for educational innovation.

Fortunately, recent theoretical and research emphasis, particularly that of the Swiss psychologist Piaget, has begun to draw appropriate attention to the child once more.

During the past decade, psychologists have discovered or rediscovered three important aspects of the early phases of child development that are of central importance for education:

(1) The tremendous plasticity of the human organism: These discoveries range from the fact that infants are capable of form discrimination within the first few days of life, (Frantz, 1963), to that of the tremendous effects of the structure of the environmental factors impinging on the infant, to intellectual growth, and to the realization that relatively young children can learn to read.

(2) The effects of early stimulation and early environmental systems on infant and early child development are tremendously complex. Some of these early experiences appear highly persistant, but many are not. The Head Start program is an excellent example. We now know a short period of intervention whether it be for three months or for a full year is not likely to have lasting effects on the child's ultimate intellectual level. In fact, the "follow through" and upward bound" programs are insufficient as well. We also need programs of adult education that might be entitled "stay on top" and "operation retread".

Further, the possible delayed effects of many early experiences have been curiously ignored. The most dramatic example of this is derived from the work of Harlow (1959) on the development of affective systems in mammals. The initial experiments indicated no undersirable consequences of substituting a piece of velvet for a biological mother during infancy. Follow-up studies, however, indicated behavior consistant with what clinicians might call a severe form of psychopathology. As adolescents and adults, the chimpanzees did not establish social emotional relations with other members of their species. The procedures producing these effects might help solve the population explosion, but I'm quite sure that other desirable goals of society would be lost. In any case, it is important to approach all of these problems of early stimulation with the understanding that hardly anything is known about the long term effects of such experiential innovations.

(3) The third major discovery (or more correctly I should say rediscovery) of recent years is that children have a mode of reasoning that characterizes an understanding of reality that is different from that of adults. (Piaget, 1954). To understand the child's conception of reality is a necessary ingredient for truly innovational education strategy. Until we do understand the principles underlying child thought, our innovations will not persist, will be neglected and misinterpreted and probably misused if used at all. Such has been the fate of most important educational innovations in the past.

The most dramatic of yesterday's discoveries about the child's world was the Freudian one that the child has an emotional life of fantasy more or less secret and inaccessible. Perhaps of equal or even more importance, however, was the discovery of people like John Dewey and G. Stanley Hall that a child has an intellectual life of his own. The idea was not entirely new. At the turn of the century, for example, Darwin had been concerned with early intellectual development, but previous educational thought had defined the child largely as a small replica of the adult. That is, the child differed from the adult mainly in terms of his lack of what he is not, rather than what he is; i.e., in terms of ignorance, incompetence and probably original sin.

Progressive education arose in opposition to these notions of the child as an unformed adult. In it's initial stages, and certainly as it was formulated, it proposed that the objective of education was the cultivation and stimulation of the child's world so that the child would grow into an adult with an adult's understanding of his world and reality. Unfortunately the careful thought and research which would give substance to this vision has been very slow in coming. And, I might add, progressive education in its original form was never really tried in the public schools despite the fact it has become the whipping boy for most that is wrong in our society today. It did gain some foothold in preschool education but there it became transformed into an educational strategy that can be summed up by "be patient, be nice, don't push, let the child play".

Emerging from a number of social forces (e.g. Sputnik) and new theoretical and research knowledge we have recently been confronted with a contrasting point of view. A number of psychologists and educators are proposing that a child can be taught anything if only the right gimmicks, the right teaching techniques, and the "right" theory of learning are used (Bruner, et al., 1966). Such a position is embarrassing to me as a child psychologist and acceptance of it should be embarrassing to any educator. While some outstanding success and significant discoveries have been achieved by this approach, I anticipate little lasting good to come from uncritical acceptance of such a position. To anticipate my conclusion, I believe that no matter how clever our programs are for the teaching of specific skills at the sensory motor level (i.e., during the first three or four years) such as reading, they are secondary to the educational goals of general cognitive stimulation related to a natural world view and to the emerging thought processes of the young child. Educational approaches designed to be consistant with this latter view will neither make the absurd mistake of separating the emotional-social development from the child's intellectual development nor ignore the importance of constructing an educational environment that instills a continuing desire to learn and particularly one that lasts beyond the second or third grade.

To return to my main theme. To give substance to the notion that a child has his own view of reality (after so many years after Dewey), we rely heavily on the forty years of child study by Jean Piaget. In many books and research reports he and his colleagues have presented results of interviews, observations and experiments on young children dealing with the stages in the child's development of concepts of physical reality including space, time, number, logic, causality, and so on.

On the basis of these data Piaget concluded that a radical change occurs in the child's modes of reasoning about at the age three and again about age five to seven. According to his theory, the thinking or reasoning of the preschool child has a logic of his own, a logic that is quite different from the adult rather than being simply a weaker form of an adult logic or a reflection of ignorance of adult concepts.

Although American psychologists rejected Piaget's observations and conclusions for a number of years because of methodological inexactitude, today psychologists and educators are taking a new and very close look at his ideas, methods, and findings. In fact, it is not too strong to say he is the dominant force in child psychology and education today. Regardless of the outcome of attempts to verify his findings and the confirmation or disconfirmation of his theory, the strategy he has proposed in the study of cognitive development will at least give substance to the idea that the child's world is different from that of the adult. Most specifically, he emphasized that the child helps to build his own concepts of reality and will not accept the ready-made adult-imposed reality as his own.

Two aspects of children's reality concepts that are central to Piaget's thinking, albeit a limited aspect of his general theory, are: first, that children fail to make distinction between "subjective" and "objective" aspects of the world; and secondly, that in acquiring an "objective" view, or adult mode of reasoning, children move through an invariant sequence of cognitive stages that determine their learning characteristics (Inhelder, et. al., 1966). Both of these general ideas or working hypotheses are significant for educators and should be subjected to continual thought and analysis in terms of the arious subject matter areas and goals of education.

The child's failure to differentiate subjective experiences from objective reality components of his experience pervades his behavior and thinking. A wide range of illustrative examples are available from current and past researches. Let's take first what may appear to be an irrelevant example. We all realize that children find it difficult, at times, to separate day-dreams or night-dreams from real happenings. Piaget insists we should not dismiss the child's interpretation of his dream experience as due to the inadequacy of the child's mind but rather as a product of the inherent logic of the child's thought processes and its consequent "realism" characteristic. (Piaget, 1954) One aspect of realism is confusion of thoughts with things and things with that for which symbols stand. Children between ages two and three often seem to react to dreams, to pictures and toys of animals, and objects as though they were really the animals they represented. Perhaps you have had these experience of a young son or daughter who broke into tears as you cut the bunny off the Easter cake or who became quite upset that you were unwilling to accept his dream experience as real. These everyday examples of children's reactions to dreams are, then, quite relevant to what happens in other areas of their early learnings. The failure to differentiate subjective and objective components is characteristic of a child's adaptations to his environment, including the educational environment and the concepts we attempt to teach him.

One of the major results of the differentiation of subjective and objective is the construction of a world of permanent and unchanging objects and events systems. The infant under eight to ten months does not have a conception of the permanent object. When he is reaching for a bright toy and it is covered with a handkerchief, he stops reaching. The toy no longer exists for him. By one and one half he knows objects permanently exist even if he cannot see them; however, it is not until the age of six or seven that he begins to view physical dimensions and identity as unchangeable things that only appear to vary under different conditions.

For example, we could take a five year old from a kindergarten and seat her in front of the table with two brightly colored necklaces laying side by side. The necklaces are of equal length and their ends are neatly aligned. The child is told to pretend the blue one is "hers" and the red one is "mine" and our problem is to decide which necklace is longer. The little girl will probably be a little puzzled by the question since she replies with conviction that both necklaces are the "same length". I pick up one necklace and make a circle of it and ask her to tell me which necklace is "longer" or is mine still as "long as yours." The little girl stretches her arms to illustrate length and beams, "Mine is the longest. You made yours into a ring and mine is all this long."

Or a young child might be presented with two boards about two feet square, covered with green cloth. On each board there are several barns and a cow. The child is asked to pretend this is a field and to indicate which cow has the more grass to eat. Interestingly enough, but consistant with our earlier statements, when the barns on both fields are solidly packed in one corner the child answers "the cows have the same amount to eat in each field". However, if we spread the barns on one field into various locations and leave the barns on the other field grouped together, the child then indicates the cow on the field with the barns in various locations has less to eat than on that field where the barns are closely grouped (Piaget, 1947).

Examination of these kinds of data and ideas, including the child's conception of length, substance and space led Piaget to discover the child's thought during, this so-called prelogical stage is not due to the child being illogical in the adult sense but to the fact he places too much trust in appearances: i.e., the child tends to respond to the perceptual and subjective elements of the situation. By the time the child is six or seven, however, the length of a string of beads is conserved; that is the length will not change even if its "longness" disappears when it's ends are joined in a circle. The basic question is how do children gain the concept of length as a dimension so that the perceptual cues presented by the changes in shape are ignored? Today most psychologists, along with Piaget, see that the child's mind is internally consistant and yet externally illogical, a kind of Alice in Wonderland where lengths, widths, weights, distances have as much consistency and constancy as Silly Putty.

This new picture has aroused wide-spread debates among psychologist and educators. It raises a host of questions about the understanding of mental processes in general and the education of young children in particular. For example, is intellectual development preset, as in much of the child's physical growth? Or, can it be speeded up by experience through teaching? Does the child develop through a series of specific stages on his way to adult reasoning? What are the long range consequences of attempts to speed up the child's acquisition of adult forms of reasoning? Piaget's theory and research, and research of many American psychologists, has begun to give us some tentative answers. By six or seven children have developed the idea of logical necessity in the adult sense within a restricted range of their experience. This acquisition is manifested through the "conservation" of length and area, as mentioned above, as well as a number of other concepts pertaining to the physical world. For example, at about age six or seven the number of elements in a collection remains unchanged regardless of how the elements are displaced or arranged. Conservation of substance and length occurs at about age seven or eight and weight and volume at ten to fourteen years of age. (These ages for the various acquisitions of the conservation concepts are, of course, only gross averages but do not in any way detract from Piaget's major conclusion that the attainment of conservation points to the formation of a new stage in the child's mental development.) Thus, most psychologist have been convinced these phenomenon respresent qualitatively changes in the child's mode of reasoning and that the phenonomena Piaget describes are stable and accurate discriptions of cognitive development processes.

A second aspect of Piaget's position has not been accepted so readily, however. He maintains the changes in thought processes are largely spontaneous and occur independently of teaching or specifically directed ("provoked") experiences. The controversy centers on two basic questions. (1) Can the child's logic, as indicated by the conservation acquisitions, be explained as resulting from qualitatively different modes of reasoning characteristic of the preoperational stage _or_ is it merely the result of a naive trust in, and strong tendency to respond to, perceptual aspects of the situation? (2) Does the transformation from prelogical modes of reasoning represent an _invariant order of development_. The answer to the first question now is fairly clear, in my opinion: The child's performance on the conservation task is not due to merely a naive trust in perceptual cues nor to inadequate development of language facility.

The answer to the second question must be more tentative but the evidence to date indicates that some sort of ordering or developmental sequencing is most likely. Cultural and environmental factors, or innate capabilities, may make one child or group of children reach a given stage of development earlier than another, but all children appear to go through the same order of the modes of reasoning regardless of environmental structure or amount of direct teaching. It would appear the differentiation of the subjective from the objective world is a major developmental transformation (or task, if you wish) requiring considerable experience, time, and active participation of the child. Further, children appear to move through a series of qualitatively different modes of reasoning from birth through adolescence before there is adequate achievement of this distinction in a large number of knowledge domains.

We should mention one other factor. Besides the issues we've discussed so far, there is one major problem which must be faced before we can say a young child has a cognitively different experience of reality than the adult. The child's acceptance of the subjective as real may not be simply verbal or cultural ignorance but could be due to the child being more swayed by his wishes and fears than are adults. This is the explanation favored by psycholoanalytic-oriented psychologists. The Freudian view sees the young child as dominated by the pleasure principal. Without denying that desire, wishes and fears are reflected in many problem-solving tasks, the explanation is inadequate. We find children's reality attitudes are highly consistent whether situations involve fears or wishes concerning quite neutral topics. The consistency across many levels of "emotional" involvement cannot be explained by the child's acceptance of "unreality" if it were only a product of wishes and fears.

The general conclusion to be drawn from recent research is largely confirmatory of Piaget's view that young children's mode of thinking and experience of reality are different than the adults and that these differences are not due to the children's ignorance, or to lack of teaching, or to lack of control over wishes and fears. If the young child's sense of reality is different than the adults, should we exploit this difference by stimulating the child's exploration of the world he will later consider unreal; or, should we stimulate his development of a more mature sense of reality? Often the young child's openness to the world of magic and unreal is considered a unique capacity for imagination and creativity. Preschool could be considered as fundamentally the best time for such exploration through play. At the other extreme is the view the child should be taught objective skills (the three R's) and knowledge as soon as possible.

Neither of the above views take into account that the preschool orientation to reality is a developmental stage which needs to be intergrated with later stages of development. To put off reality until elementary school is only to divorce the child's preschool world of the subjective from the elementary school child's world of the more objective.

To focus during early cognitive development on training for specific skills is to teach the child a body of information whose meaning to the child is full of subjective distortions. The child may invest these early verbal and number skills with magical meanings which interfere with later learning and, more important, may create the aversion to self-motivated learning we note so much of in adults and older children.

The controversy surrounding these issues has proved a healthy stimulant for educational innovation. Too often, however, the proponents of each position have taken an "all or none" stance and thus attracted nonthinking disciples to their particular fold. Education is devoted to multiple goals and I would like to see educators and psychologists continue to explore the multiple possibilities of generating optimal educational strategies for educating young children. Neither Piaget, nor other modern theorists, offers specifics; but there are many significant and far ranging issues and problems to be solved that are not apparent in the polemics of the dogmatic "innovators." More innovations, more experimental approaches, more ideas -- these we need from all educators whether teacher, curriculum advisors, or administrators.

The dogma of the three R's needs to be replaced with a new set of principles (probably to become dogma in its on good time) which we might call the three T's: Titillation, Time and Tools. These terms describe an orientation and educational strategy that are independent of particular subject matter area. But they are, in my mind, three indespensible aspects of learning at any stage of development and are of particular importance in early childhood education. Taken together they can provide the kind of environmental-educational situation that promotes not only intellectual growth but the total organismic development of the child.

Titillation refers to a set of environmental conditions in which the teacher and curriculum materials together represent an educational strategy capitalizing on the particular prior experience and current cognitive development of children. The experiments in English schools have clearly demonstrated that if children are provided a sufficiently informal setting and broad range of educational activities, they will select the appropriate activities in much the same way that free selection of food results in children meeting appropriate nutrient requirements. Certainly we can force children to learn many kinds of things and often have done so. The consequences of such force feeding techniques, however, have been generally undesirable resulting in lethargy, lack of curiosity, and a continual need to force children to learn things by offering external and extrinsic rewards such as grades, money, and social approval. Once again, it is time that educators at all levels begin to recognize a dualism with respect to motivation: that is the difference between intrinsic and extrinsic motivation (Smock & Holt, 1962). Children are always motivated to learn where the problems with which they are confronted represent areas designed to capitalize upon the adaptive requirements and capacities of the child at that particular stage of development. We too often confound the problem of motivating children by either failing to match the task with his current cognitive capacities or fail to recognize that many skills and much knowledge can be taught through many different media. We too often segregate subject matter into neat little compartments that fit our conception of reality, or that of our teachers, and fail to recognize that children can learn much about measuring or quantitative concepts while engaging in which we might term "art". Further, we are so fascinated by our own conversation and voice that we overly emphasize the value of verbal learning when much of the same material could be learned much more readily, easily and with more permanent effects where we allow the child to participate in a concrete way and with concrete materials in solving problems requiring the same skills.

Time refers to two aspects of the educational problem: first, the timing of educational experiences; and secondly, the necessity for recognizing variation in amount of time children require to acquire certain skills or knowledge. The timing of educational experiences must be geared to the characteristics of the child (of which I have emphasized so much in this paper); and secondly, it may involve a value decision. I know neither evidence nor reasons, from the point of view of our current knowledge of learning capacities of children, why children cannot be taught to read during pre-school. Whether or not such early skill learning might have later undesirable side effects is yet to be determined. Nor do we know for sure that it has all the positive side effects that have been so emphasized. But certainly the time spent in such training should not deprive the child of opportunities for other kinds of acquisitions equally important for later learning whether they be in terms of a specific knowledge and skills or related to the personal-social characteristics that are desirable from the point of view of society. (Or the extent or persistence of motivation to learn.)

Time is also important with respect to variation in children's ability to solve particular problems. There is probably no ideal variation of optimum spacing of a particular task with respect to the amount of time necessary to all children to learn. The overemphasis on clock hours and definite temporal end-points for "education" is as detrimental to the pre-school child's cognitive growth as it is to that of the graduate student.

Finally, tools refer to the basic skills that are anticipatory of the child's adaptive requirements during later years. In later childhood and adulthood the child is confronted with complicated technical and cognitive problems as well as social, moral and political ones. Each child needs a certain set of specific tools such as reading and mathematics to be a constructive citizen and to live a good life. People may vary as to what these basic skills or tools might be, but I am sure we would all agree that reading, mathematics, logic and understanding of social interaction dynamics are among the most important ones. Each of these, however, can be taught with an infinite variety of subject matter content. It is very difficult to separate economics from history or history from art or art from many other contents. The important thing is to provide a variety of possible contents which will tap the variety of interests, experiential backgrounds and cognitive level of the child.

A final comment is, perhaps, in order. The new discoveries referred to earlier (relatively high-level capacity of young infants, plasticity of the human organism during early development, and the different modes of reasoning during early childhood) indicate the potentiality for accelerating cognitive development of children in diverse ways. Moving all or some of the three R's and other subjects, to the preschool level need not distress us, nor is it inconsistent with the broad generalizations to be drawn from the current theory and research on cognitive development. Such decisions, however, need to be viewed in the proper perspective of the multiple goals of education and more essentially, the nature of the thought process during the early stages of development.

The world of the child and the natural processes of his development to adulthood are such that an educational strategy is demanded which places appropriate emphasis upon titillation, time, and tools.

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